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Engineering News-Record

Test Drilling for Dam Site in Mountain Stream in California

Population Density as a Basis for Housing Regulations — *Intensive Rochester study indicates that improved transit, industrial decentralization, zoning and other changes render dense tenement populations unnecessary in most cities.*—By **Frank P. Cartwright.**

An Investigation into the Use of Bulk Cement—*Discussion of the methods and advantages in the use of bulk cement on large concrete jobs prepared by the staff of the Turner Construction Co., N. Y. City.*

Stresses in Horizontal Pipes on Rigid Saddles —*Formulas and tables based on theory of radial concentrated loads and fixity of shell at saddle support.*—By **Theodore B. Parker.**

Large Apparatus for Tests of Lateral Earth Pressures —*Measures pressure against 6-foot retaining wall—Test with sand gives satisfactory check on theory*—By **G. M. Braune and Jacob Feld.**

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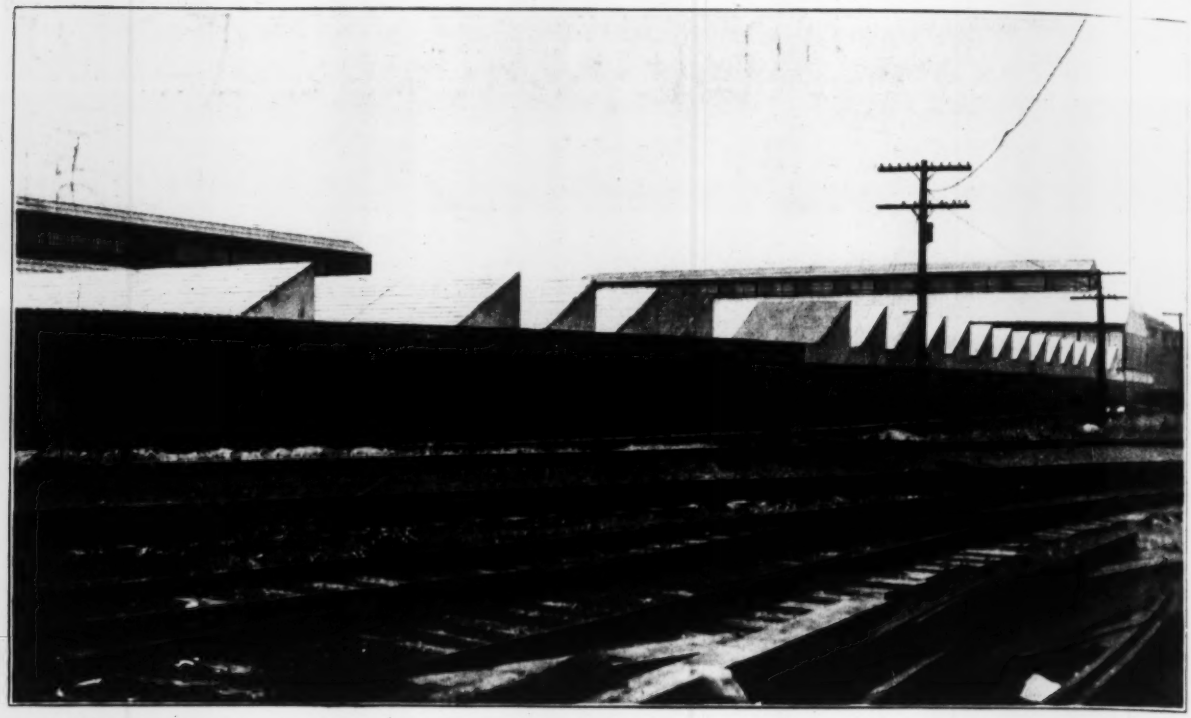

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ENGINEERING NEWS-RECORD

DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

E. J. Mehren, Editor

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Bulk Cement for Buildings

FOR some years the use of cement in bulk to reduce handling costs and the nuisance of bag disposal has been advocated by some of the cement companies. The practice, however, has never been widely used, mainly because it involves so radical a departure from current methods. Where it has been used, too, there have arisen at times unexpected difficulties which seriously impeded progress. Nevertheless, the elimination of the bag, with its almost imperative man handling and its dust and storage complications, should be most desirable if it can be economically and effectively accomplished. For that reason the Turner Construction Company's study of the problem as it is applied to buildings, which is reprinted on another page, deserves careful reading and discussion. Any practical experiences in the use of bulk cement, particularly those in amplification of the points brought out in the article, will be welcomed as additions to an interesting phase of contracting economics.

Gravel-Road Economics

WE ARE FAR from knowing when we reach the limit of economic use of secondary types of road surfacings, such as gravel and sand-clay. Experiences vary in different parts of the country and only where the types have been under observation for a long time is any fairly safe determination of this matter possible. For that reason, the study which the Bureau of Public Roads has begun of gravel and of sand-clay roads should prove very valuable. It is undertaking, with the help of various state agencies, to determine the maximum traffic which roads of these types will carry economically. Included in the study is an inquiry into the characteristics of their behavior when they get near their maximum traffic carrying capacity limit, with a view to determining what can be done to increase this maximum carrying capacity. It is just information of this sort that will gradually put our road practice on sounder and sounder grounds.

The Large Pipe Problem

APPROXIMATE analysis is the great tool of practical engineering. Rightly handled, and backed by a sound understanding of the physical actions concerned, it solves a great number of problems that are not susceptible of exact solution within reasonable limits of time and effort. But there are some practical problems in which it fails, where approximation shoots so wide of the mark that exact analysis is indispensable unless absurdly large margin of ignorance is allowed, or unless empirical trial-and-error development is relied upon. The design of large horizontal pipes carrying water is a problem of this kind. Practical designing fails in attempting to deal with it, as failures of pipes attest. Theoretical analysis such as is given by Capt. T. B. Parker in this issue is necessary. For the particular case of saddle or pier support the formulas and tables of this article represent design data of great value. A problem of more general kind is confronted in the case of buried or partly imbedded pipes, and pipes carrying surcharges. The case is then more complicated, and hitherto separate analysis of each problem has been required. Another engineer, however, dealing with cases of this class, has been able to summarize them by tables and formula in a second article, to be published shortly. The two articles in conjunction will constitute a collection of fundamental reference data on pipe analysis.

Progress of the "American Plan"

CONSIDERABLE impetus has been given in the building trades within the past few months to the "American Plan" of employment. The sentiment for the plan, which is nothing more than a sincere attempt to operate an open shop—to use union and non-union men together, without prejudice—is particularly strong now as a reaction against union-labor unreasonableness, an unreasonableness that was strongly indicated by the dispassionate display of facts made by Colonel Gow in his paper before the Boston Society of Civil Engineers. (See *Engineering News-Record*, June 9, p. 991.) Of course, it is well known that in the past the so-called "open shop" was not an open shop in fact; it was open to non-union men, but closed against union men. The employers used the term to deceive, knowing that it would gain the plaudits of the public. The American plan professes to be sincere and to attempt to use both union and non-union men on the same terms. It is to be expected that union labor will fight the plan as bitterly as the employers who have had costly experience with union-shop operation oppose the latter. The sentiment on behalf of the plan may be gaged by the action in San Francisco in raising a million dollar fund with which to promote its growth. The San Francisco employers determined on this measure after union labor had refused to accept a wage reduction recommended by an impartial arbitration board. The movement is growing rapidly in other large cities, and growth may be expected to continue until union working agreements have been modified to reasonableness and union wages have come down to a point that the public deems commensurate with the conditions and demands of the present time.

Credit to the Manufacturer

IN THE issue of July 21, reference was made to the presidential address of R. W. Newman before the South African Society of Civil Engineers. One additional feature deserves special emphasis. In urging upon his fellow members a close study of construction equipment, he gives the manufacturers great credit for what they have done in making it possible for engineers to reduce the cost of work. He gives them credit not

only for the development of materials and machinery, but also for having a great fund of experience regarding the uses of those materials and the efficient operation of plant. He counsels his hearers to profit by that experience, whether through the literature published by the manufacturers or through the well-informed salesmen who represent them. We, in this country, do know what the engineer owes to the manufacturers, but seldom, either through the spoken or the printed word do we give them credit for their part in engineering development of the present day. We accept their work. We use daily the tools on which they have spent fortunes in development, expenses with little thought of its amount. Our art surely could not have developed to its present degree of perfection were it not for their vision and, principally, their courage. That the manufacturer is spurred on in his endeavors by the hope of profit does not belittle the contribution that he is making to engineering. If he hopes for profit, he also risks much in the development of his devices. His accomplishments entitles him to a place in the construction trinity, alongside the engineer and the contractor.

Cleveland Station Decision

IF THE COMMISSION'S summary of the petitioning and opposing cases is a fair one, the Interstate Commerce Commission in refusing to sanction the Cleveland Public Square station project decided in accordance with the weight of evidence. The decision is not based on one point. The commission is unwilling to sanction the "enormous expenditure"—$72,000,000, as against $42,000,000 for the project on the Mall site—particularly as the latter would take in the four big roads, while only three roads plan to use the Public Square terminal. It points out the diversity of view with reference to street traffic congestion at the Public Square, giving, in the commission's opinion, at least reason to doubt the wisdom of locating the station there. It holds that the views of the public on station location are entitled to considerable weight, but it points out that the project as put before it is not the same as that which the citizens of Cleveland approved in 1919, the greatest difference being that the proposed public square terminal will not be "a real union passenger station" (the argument of the referendum campaign), since only three railroads will enter it. Moreover, there is now no question of providing work for returned soldiers—another campaign argument. Finally the commission gives such space to the control and financial features as to indicate that these were a very considerable factor in reaching the decision. A certain O. P. Van Sweringen would control the terminal company during the construction period, although the railroads would own all the stock of the terminal company and provide the financial credit which would make possible the marketing of the bonds. Furthermore, the Van Sweringen interests would control the "air rights" above the terminal, and the reader will draw the inference from the report that the commission did not consider the amount to be paid for such rights as adequate. The commission itself says that it is not persuaded that the proposed reservation of air rights "is in accord with sound public policy."

Obviously in a real-estate transaction of such dimensions it is not improper for a real-estate agency to be employed. In this case, however, it seems that the railroad companies desire to hold down their investment; some one else then must carry it. It is apparent that this is the function proposed to be performed by the Van Sweringens. Their purpose and function may be entirely legitimate but it is manifest that the railroad companies have failed to show it to be so clearly enough to remove doubts of the character of the transactions from the mind of the commission.

All in all, if the commission's report is fairly representative of the testimony, it seems that no other decision could be reached.

Concerning Detours

SOME of the state highway departments, in addition to the placing of signs to mark detours around roads closed for repair, are issuing detour reports designed to keep the traveling public informed as to the condition of the principal routes of the state highway system. Through the medium of the daily press this information can be transmitted directly to the highway users with the result that many miles of useless travel may be avoided and many gallons of gasoline saved. Of equal importance, however, is the increase of the public's good will toward the state highway department which follows practices of this sort. Until recently highway engineers failed utterly to realize the significance of posting detour routes properly. Intent upon getting construction work finished rapidly, they were satisfied to let traffic shift for itself where main routes were closed and substitutes had to be used. This attitude on the part of highway officials is fast disappearing. They are beginning to realize that the posting of detours is an important point of contact between the state department and the public, and that, justly or unjustly, the highway department is judged by its practice at detours. It is so simple a matter to place signs indicating detour routes that there is no excuse for failure to do so. Dealing largely with material things, the engineer, time and again, gives little thought to the psychological aspects of his work. The railroads and the large industrial organizations long ago learned that a public-be-damned policy was fatal to their own interests. Some of our state highway departments are lacking in this knowledge. Highway detours—necessary evils as they are—offer to the engineer a means of establishing cordial relations with the public instead of bringing down upon the highway department the wrath of every motor vehicle driver. Detour posting can be the best—or the worst—form of advertising in which a highway department can indulge.

Commerce Commission's Decision on Labor Inefficiency

ALLOWANCE to the railroads has been denied by the Interstate Commerce Commission for additional sums spent for maintenance due to the decreased effectiveness of labor during the six-month guarantee period. In view of the part the government had in decreasing the effectiveness of labor through the consummation of the national working agreements, the decision is unfair to the railroads.

In taking over the carriers, the president recommended that definite guarantee be given to maintain the properties in as good repair and as complete equipment as before. Subsequently, this provision was included in the "standard contract" between the Director General

of Railroads and the carriers, with provision that annual expenditures for maintenance equivalent to the average of the test period, with due allowance for differences in "cost of labor and materials" should serve as full compliance with this stipulation. It was also provided that the results should be "as nearly as practicable, the same relative amount, character, and durability of physical reparation."

The controversy which the commission has just decided is over the construction placed on the words "cost of labor." The railroads have contended that cost of labor does not mean *price* of labor, or wage, and have asked for full allowance for "labor inefficiency" due to the national working agreements and other causes. The commission has denied their request, and is willing to make allowance only for differences indicated by actual wage scales.

The commission's decision is based on a legal type of argument intended to determine what the contracting parties had in mind by the word "cost" when the standard contract was drafted. It places relatively little weight on the significant words about results being "as nearly as practicable, the same relative amount, character, and durability of physical reparation." The commission contends, too, that such labor inefficiency as may have existed was a "war burden" that the carriers would have had to bear had the properties not been under federal control. The main issue, if equity is to be considered, namely, what amount is fairly due the railroads, is not considered.

Yet the government's responsibility for the national working agreements cannot be denied. That these agreements, too, were responsible for a large proportion of the railroad labor inefficiency is generally admitted. On the other hand, it must be conceded that the determination of that proportion is not easy. There was, everybody well knows, a heavy lapse in efficiency in every line of endeavor. The losses incident to that general lapse the railroads must bear, even as other industries bore them. Some approximation of the government's responsibility could, however, have been made. Such procedure would have been in accord with the spirit under which the carriers were taken over.

Ford and the Muscle Shoals Power

HENRY FORD is the modern magician. He makes more automobiles quicker and cheaper than anyone else; he converts, with alchemic ease, the base metal of business liabilities into the gold of assets and, wonder of wonders, he buys a railroad and makes it pay, or at least he says it does. When he offers to take off the government's hands that hundred million dollar white elephant known as the Muscle Shoals development, it is not strange that the man in the street thinks that the government would make a good bargain in letting him have it. Reports from Washington, indeed, indicate that the authorities there, in the absence of any other private offer, are favorably inclined toward the proposition, as the only way out from government operation of the project, which few want to contemplate.

In effect, Mr. Ford offers to pay on a renewable 100-year lease a rental of 6 per cent for the cost of completing the two power plants and to amortize the total cost of those plants (that is, what has already been spent plus what will be required to complete) at 4 per cent over 100 years. In addition, he will pay $5,000,000 for the title outright to the nitrate properties which cost the government during war years $87,000,000 to build. His amortization, however, is based on a cost of $48,000,000 for the power plants, whereas the government's estimate of that cost is $75,000,000. In other words, assuming his rental percentage to be fair, he is asking the government to write off $109,000,000 on the cost of a $162,000,000 plant and to turn it over to him, at a rental based on a low estimate of what it will cost to complete, practically in perpetuity, with quite proper provisions for war-time temporary capture by the government and some hazy provisions for supervision of rates to be charged for power and products in times of peace.

Obviously, the government is not going to make any money on any such agreement. The question is, as it is in the disposition of all the war-time plants, not how much can be made but how little must be lost. Do we want another such case as that of the steamship "Leviathan," for which a year ago the Shipping Board refused an inadequate though substantial offer, to find now that they may have to pay someone to take the ship to sea and sink it, so useless and expensive does it appear to be?

The issue at Muscle Shoals, however, is complicated by the water-power element. If it were only the nitrate producing plants that were involved, the government would be quite justified in putting them up to the highest bidder, with proper qualifications as to charges and war preparedness. Those plants were built by the government in prospect of war; their operation is not properly a government function and no one could rightfully complain if Mr. Ford were awarded them on the highest bid. The water power on the Tennessee River, on the other hand, is a national property, subject to the same control as the power in all of the federal lands and on all of the navigable rivers. By act of Congress in June, 1920, all such powers are subject to certain rules and regulations, prominent among which are absolute control by the Federal Water-Power Commission, the right of recapture by the United States and the renewal of lease at 50-year intervals. None of these provisions are included in the Ford offer. On its face that offer puts Muscle Shoals in a class by itself, and by accepting it Congress would violate the principles of water-power control fought over for many years prior to 1920 and crystalized in the 1920 Act.

It may be that conditions today do not justify anyone but Mr. Ford, whose industrial requirements are unique, in making an adequate proposal, under the Federal Water-Power Act, for the Muscle Shoals power, but that power is so great and its future market so sure that it cannot possibly be more than a few years before other private interests will be ready to consider it. Rather than to go backwards in our administration of public water powers, it would be the better part of judgment to demand of Mr. Ford that he do not go beyond the law in his proposal for the power and if a bargain cannot be made today on that basis, to postpone all action on the whole Muscle Shoals development. The nitrate plants can be kept in good stand-by order without undue expense, and the dam cannot deteriorate. Money would be lost in the dispersal of the construction plant, to be sure, but the amount would be small in comparison to the total cost of the project. Uncontrolled ownership of public water powers is a thing of the past; it should not be permitted to be revived.

Stresses in Horizontal Pipes on Rigid Saddles

Formulas and Tables Based on Theory of Radial Concentrated Loads and Fixity of Shell at Saddle Support

By Theodore B. Parker
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THIS study is an effort to establish a rational basis for the design of large horizontal pipe lines with supporting saddles or cradles, where it is necessary to depend upon the saddles for lateral support. As the size of such conduits increases, the tendency toward radial distortion, due to unequal pressure at top and bottom of the shell, becomes a very important factor. Several large pipe lines have collapsed from this cause, and in other cases unexpected weakness has developed. It is toward a determination of the effects of this distortion that the present analysis is directed.

The critical condition as regards distortion (but not as regards stress) occurs when a pipe is just full of water, with zero pressure at top of shell. Further increase in static pressure produces a uniform increase in shell tension, which tends to return the pipe to a true circle. This additional tension is added algebraically to the stresses resulting from the unequal water pressures.

To proportion the structure it is necessary to determine the stresses in the pipe shell, the distortion or deflections, and the reactions against the saddle.

Assumptions—Previous solutions of this problem (as that given by B. Haukelid in *The Engineering Record*, June 14, 1913, p. 669) have largely depended upon certain assumed distributions of load over the supporting saddles. Since this distribution is one of the most essential things to be determined, and varies greatly with different conditions, it should not be assumed. In the present analysis the only such assumption made is in regard to the *direction* of the saddle reactions: Forces between pipe shell and saddle are taken as acting radially. Distribution and intensity of pressure at various points in the saddle are then calculated. In this way a reasonable basis is furnished for the design of both pipe and saddle. The methods employed could also be used to determine tangential components of the forces between pipe shell and saddle. This would furnish an exact but less simple solution. In view of the usual uncertainties in this class of construction, such refinement does not seem justified.

Weight of shell is neglected throughout. Other assumptions made are those commonly used in structural theory, and need no explanation.

The least-work method is used. By this means the radial deflection of the pipe shell is determined for two cases, Case I, pipe just full of water and supported on bottom element; Case II, empty pipe supported on bottom element, but acted upon by two equal radial forces of unity, symmetrically placed. By equating outward deflection from water pressure to inward deflection due to radial forces, it is possible to determine the magnitude of any single pair of reactions. In the same way the magnitude of any number of symmetrical radial forces may be determined by equating inward and outward deflections at each support and solving the resulting equations.

Saddle reactions may be assumed to consist of any desired number of pairs of radial forces. The magnitude of these forces may then be determined as outlined above. Resultant stresses and deflections in pipe shell follow.

In the analysis, bending moments producing compression in the outer fiber of the pipe shell will be taken as positive (+).

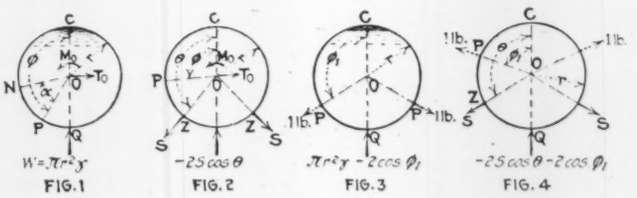


FIG. 1. FORCES IN PIPE FULL OF WATER

FIG. 2. FORCES IN PIPE WITH CONCENTRATED LOADS

FIG. 3. DEFLECTION RELATIONS, PIPE FULL OF WATER

FIG. 4. DEFLECTIONS FOR PIPE WITH CONCENTRATED LOADS

Shell Stresses for Case I (pipe supported only along bottom element, and just full of water)—Since the loading is symmetrical, the shear at point C (Fig. 1) is zero, leaving two unknowns, the tension and bending moment at the top, *reduced to center of pipe* as T_o and M_o. The pipe is considered as cut in two on its vertical diameter, being then two cantilever beams joined at the bottom, each acted upon by the force T_o, the moment M_o, the water pressure, and the reaction and moment at its lower end. Reduction of the crown tension and moment to the center of the pipe greatly simplifies the algebraic work.

The portion of the left-hand cantilever beam above any point P is held in equilibrium by T_o and M_o acting at O; by the water pressure, whose moment about P is M_L; and by a tension and bending moment T and M acting at P. For one linear inch of the pipe the water pressure at any point N above point P, on the arc ds, is $\gamma hds = \gamma hrda = \gamma r[r - r\cos(\phi - \alpha)]d\alpha$. The moment arm of this force about P is $r \sin \alpha$, and its moment about P therefore $\gamma r^2[r - r\cos(\phi - \alpha)] \sin \alpha\, d\alpha$. The total water-pressure moment M_L is the integral of this elementary pressure from 0 to ϕ, or $M_L = \gamma r^3 (1 - \cos\phi - \frac{1}{2}\phi \sin\phi)$. Taking moments about P, and using this value of M_L, the stress moment M at P is,

$$M = M_o + \gamma r^3(1 - \cos\phi - \tfrac{1}{2}\phi\sin\phi) + T_o r\cos\phi \quad (1)$$

and taking moments about O, the tension in the shell at P is found to be

$$T = \frac{M - M_o}{r} = \gamma r^2(1 - \cos\phi - \tfrac{1}{2}\phi\sin\phi) + T_o\cos\phi \quad (2)$$

Then the total work (both sides of pipe) is

$$W = 2\int_o^{\pi} \frac{M^2 r d\phi}{2EI} + 2\int_o^{\pi} \frac{T^2 r d\phi}{2EA}$$

By the theorem of least work,

$$\frac{dW}{dM_o} = 0; \frac{dW}{dT_o} = 0$$

To apply these, substitute the expressions for M and T given by (1) and (2) in the equation for W just

above, and then differentiate and integrate. The resulting equations are,

$$\frac{dW}{dM_o} = 0 = \frac{2\pi r}{EI}(M_o + \tfrac{1}{2}\gamma r^2)$$

$$\frac{dW}{dT_o} = 0 = \frac{2\pi r^2}{EI}(\tfrac{1}{2}T_o r - \tfrac{3}{8}\gamma r^3) + \frac{2\pi r^2}{EA}(\tfrac{1}{2}T_o - \tfrac{3}{8}\gamma r^2)$$

From these, $M_o = -\frac{1}{2}\gamma r^3$ and $T_o = \frac{3}{4}\gamma r^3$, which in turn give the crown moment $M_c = M_o + rT_o = \frac{1}{4}\gamma r^3$. The moment and tension at any point P are, from eq. (1) and (2) with the above values,

$$M = \gamma r^3(\tfrac{1}{2} - \tfrac{1}{4}\cos\phi - \tfrac{1}{2}\phi\sin\phi) \quad (3)$$

$$T = \gamma r^2(1 - \tfrac{1}{4}\cos\phi - \tfrac{1}{2}\phi\sin\phi) \quad (4)$$

Shell Stresses for Case II (empty pipe supported along bottom element, and acted upon by two symmetrical radial outward forces, Fig. 2)—Here the application of a concentrated load at Z makes it necessary to write one set of expressions for values of ϕ less than θ, and another set for values of ϕ greater than θ. Proceeding as before, and considering that portion of the left-hand cantilever above any point P, the moment of the external forces, M_L, is zero when P lies above Z, and $Sr\sin(\phi - \theta)$ when P lies below Z. Then the bending moment M at P is

$$\left.\begin{array}{l}\text{for } \phi > \theta,\ M = M_o + T_o r\cos\phi + Sr\sin(\phi - \theta)\\ \text{for } \phi < \theta,\ M = M_o + T_o r\cos\phi\end{array}\right\} \quad (5)$$

and the tension in the shell at P is found by taking moments about 0,

$$\left.\begin{array}{l}\text{for } \phi < \theta,\ T = \dfrac{M - M_o}{r} = T_o\cos\phi\\ \text{for } \phi > \theta,\ T = \dfrac{M - M_o}{r} = T_o\cos\phi + S\sin(\phi - \theta)\end{array}\right\} \quad (6)$$

The total work for both halves of the pipe, is

$$W = 2\int_o^\theta \frac{M^2 r d\phi}{2EI} + 2\int_o^\theta \frac{T^2 r d\phi}{2EA} + 2\int_\theta^\pi \frac{M^2 r d\phi}{2EI} + 2\int_\theta^\pi \frac{T^2 r d\phi}{2EA}$$

$$= \int_o^\theta \frac{(M_o + T_o r\cos\phi)^2}{EI} r d\phi + \int_o^\theta \frac{(T_o\cos\phi)^2}{EA} r d\phi + \int_o^\pi \frac{[M_o + T_o r\cos\phi + Sr\sin(\phi - \theta)]^2}{EI} r d\phi + \int_o^\pi \frac{[T_o\cos\phi + S\sin(\phi - \theta)]^2}{EA} r d\phi$$

Differentiating with respect to M_o and T_o respectively, placing the resulting expressions equal to zero, integrating and solving for M_o and T_o, gives,

$$M_o = -\frac{Sr}{\pi}(1 + \cos\theta);\quad T_o = \frac{S}{\pi}(\pi - \theta)\sin\theta$$

and the bending moment at the top of the pipe, M_c, which is equal to $M_o + rT_o$, becomes

$$M_c = \frac{Sr}{\pi}[(\pi - \theta)\sin\theta - (1 + \cos\theta)]$$

Inserting the values of M_o and T_o in eq. (5) and (6) we obtain the final values of the tension and bending moment at any point of the pipe shell,

for $\phi < \theta$,

$$M = \frac{Sr}{\pi}[(\pi - \theta)\sin\theta\cos\theta - (1 + \cos\theta)] \quad (7a)$$

$$T = \frac{S}{\pi}[(\pi - \theta)\sin\theta\cos\theta] \quad (8a)$$

for $\phi > \theta$,

$$M = \frac{Sr}{\pi}[(\pi - \theta)\sin\theta\cos\theta - (1 + \cos\theta) + \pi\sin(\phi - \theta)] \quad (7b)$$

$$T = \frac{S}{\pi}[(\pi - \theta)\sin\theta\cos\theta + \pi\sin(\phi - \theta)] \quad (8b)$$

Deflections for Case I—The radial outward deflection at any point P in Fig. 3, under *any loading*, is

$$\Delta r = \int_o^\pi \frac{Mm ds}{EI} + \int_o^\pi \frac{Tt ds}{2EA}$$

where m and t are the bending moment and tension due to *outward loads of unity* acting at points P, and M and T are the values due to the actual loading.

From a study of the stress equations previously developed it is apparent that the effect of direct tension is comparatively small. Neglecting, therefore, the second member of the preceding equation, we have

$$\Delta r = \int_o^\pi \frac{Mm ds}{EI} = \int_o^\pi \frac{Mm}{EI} r d\phi$$

Here m is the value of M in Case II, provided we make $S = 1$; and M is the value of M in Case I. Inserting their values previously found, integrating and simplifying,

$$\Delta r = \frac{\gamma r^5}{2EI}[(1 + \cos\phi_1) - \tfrac{1}{2}\phi_1\sin\phi_1 - \tfrac{1}{4}(\pi^2 - \phi_1^2)\cos\phi_1] \quad (9)$$

Deflections for Case II—The pipe is represented by the diagram Fig. 4. As before, the outward deflection at P is

$$\Delta r = \int_o^\pi \frac{Mm}{EI} r d\phi$$

in which M is the bending moment in the pipe found for Case II above, for θ and ϕ (variable angle), and m is found from the same expression for ϕ_1 (in place of θ) as fixed angle and ϕ as variable angle, and $S = 1$.

M for $\phi < \theta$,

$$M_1 = \frac{Sr}{\pi}[(\pi - \theta)\sin\theta\cos\phi - (1 + \cos\theta)]$$

M for $\phi > \theta$,

$$M_2 = \frac{Sr}{\pi}[(\pi - \theta)\sin\theta\cos\phi - (1 + \cos\theta) + \pi\sin(\phi - \theta)]$$

m for $\phi < \phi_1$,

$$m_1 = \frac{r}{\pi}[(\pi - \phi_1)\sin\phi_1\cos\phi - (1 + \cos\phi_1)]$$

m for $\phi > \phi_1$,

$$m_2 = \frac{r}{\pi}[(\pi - \phi_1)\sin\phi_1\cos\phi - (1 + \cos\phi_1) + \pi\sin(\phi - \phi_1)]$$

Combining these in the equation for Δr gives a solution in two parts,

for $\phi_1 < \theta$,

$$\Delta r = \int_o^{\phi_1} \frac{M_1 m_1}{EI} r d\phi + \int_{\phi_1}^\theta \frac{M_1 m_2}{EI} r d\phi + \int_\theta^\pi \frac{M_2 m_2}{EI} r d\phi$$

for $\phi_1 > \theta$,

$$\Delta r = \int_o^\theta \frac{M_1 m_1}{EI} r d\phi + \int_\theta^{\phi_1} \frac{M_2 m_1}{EI} r d\phi + \int_1^\pi \frac{M_2 m_2}{EI} r d\phi$$

Substituting M_1, M_2, m_1 and m_2, and integrating, we get

for $\phi_1 < \theta$,

$$\Delta r = \frac{Sr^3}{2\pi EI}\{[(\pi - \theta)\sin\theta]\phi_1\sin\phi_1 + [\pi(\pi - 9)\cos\theta + \pi\sin\theta - 2(1 + \cos\theta)]\cos\phi_1 - [2(1 + \cos\theta)]\} \quad (10)$$

for $\phi_1 > \theta$,

$$\Delta r = \frac{Sr^3}{2\pi EI}\{[\theta \sin\theta(\pi - \phi_1) + \pi\cos\theta]\sin\phi_1 + [\pi\cos\theta(\pi - \phi_1) - 2(1 + \cos\theta)]\cos\phi_1 - [2(1 + \cos\theta)]\}$$

Since most of the foregoing expressions are too cumbersome for convenient and practical use, they have been reduced to tabular form. Table I gives values of equations (3), (4), and (9) at ten-degree intervals, and Tables II and III show the values of (7) and (12) respectively. All tabular quantities are for pipes of any diameter, and are to be multiplied by a constant containing the radius, as indicated. The total weight of water is $\pi r^2\gamma$.

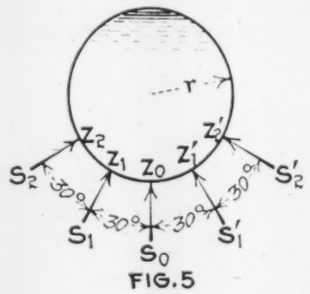


FIG. 5. CASE OF FIVE SADDLE REACTIONS

It is now possible to determine the magnitude of all saddle reactions supporting a pipe full of water. Since at any point on the pipe shell which remains on a rigid support the resultant radial deflection is zero, it follows that the outward deflection due to water pressure alone must exactly equal the inward deflection due to the supporting reactions. If these saddle reactions be represented by a number of symmetrical concentrated forces, it becomes possible to write this equation at each panel point in terms of the unknown quantities. Thus a series of simultaneous equations is obtained, equal in number to any desired set of unknown forces, and capable of algebraic solution. For approximate results a small number of points may be chosen, while for greater precision the forces may be subdivided indefinitely.

Example—The following simple example will serve to illustrate the general method: Consider a pipe supported as shown in Fig. 5, and just full of water. At points Z_2 and Z_2' the outward deflection due to water pressure alone (Table I, $\phi = 120°$) is $0.1392\ \frac{\gamma r^5}{EI}$. The inward deflection due to forces S_2 and S_2' (Table III, $\phi = 120°$, $\theta = 120°$) is $0.3035\ \frac{S_2 r^3}{\pi EI}$, and the inward deflection due to forces S_1 and S_1' (Table III, $\phi = 120°$, $\theta = 150°$) is $0.1340\ \frac{S_1 r^3}{\pi EI}$. Hence, if there is no radial movement at points Z_2 and Z_2',

$$0.1340S_1 + 0.3035S_2 = 0.1392\pi\gamma r^2 .$$

Similarly, from the absence of radial movement at points S_1 and S_1',

$$0.0901S_1 + 0.1340S_2 = 0.0662\pi\gamma r^2$$

Solving the above equations, and placing $\pi\gamma r^2 = w$, we find that

$$S_1 = 0.152w \text{ and } S_2 = 0.392w$$

Then $S_0 = w - 2(S_1\cos 30° + S_2\cos 60°) = 0.344w$

To obtain the deflection or bending moment at any point in the shell it is only necessary to compute the algebraic sum of the deflections and moments resulting

TABLE I. BENDING MOMENT, TENSION, AND RADIAL OUTWARD DEFLECTION DUE TO WATER PRESSURE ALONE

ϕ	$\frac{M}{\gamma r^3}$	$\frac{T}{\gamma r^2}$	$\frac{\Delta r}{\gamma r^5 2EI}$	ϕ	$\frac{M}{\gamma r^3}$	$\frac{T}{\gamma r^2}$	$\frac{\Delta r}{\gamma r^5 2EI}$
0°	0.7500	+0.2500	—0.2338	100°	0.1840	—0.3160	+0.1316
10°	0.7386	+0.2387	—0.2624	110°	0.1835	—0.3165	+0.1424
20°	0.7054	+0.2054	—0.2050	120°	0.2181	—0.2819	+0.1392
30°	0.6526	+0.1526	—0.1712	130°	0.2916	—0.2084	+0.1234
40°	0.5841	+0.0841	—0.1276	140°	0.4062	—0.0938	+0.0977
50°	0.5051	+0.0051	—0.0776	150°	0.5620	+0.0620	+0.0662
60°	0.4216	—0.0785	—0.0250	160°	0.7923	+0.2574	+0.0347
70°	0.3405	—0.1595	+0.0258	170°	0.9885	+0.4885	+0.0100
80°	0.2691	—0.2309	+0.0709	180°	1.2500	+0.7500	.....
90°	0.2146	—0.2854	+0.1073	....	.....	.....	.....

TABLE II. BENDING MOMENT DUE TO TWO RADIAL OUTWARD FORCES

(Coefficients to be multiplied by $S \div \pi$, eq. 7)

ϕ	ϕ-90°	100°	110°	120°	130°	140°	150°	160°	170°
0°	+0.5708	+0.5486	+0.4900	+0.4069	+0.3113	+0.2147	+0.1278	+0.0591	+0.0151
10°	+0.5469	+0.5277	+0.4726	+0.3931	+0.3011	+0.2079	+0.1238	+0.0573	+0.0146
20°	+0.4761	+0.4657	+0.4208	+0.3522	+0.2710	+0.1876	+0.1120	+0.0519	+0.0133
30°	+0.3604	+0.3644	+0.3362	+0.2854	+0.2217	+0.1546	+0.0927	+0.0431	+0.0110
40°	+0.2033	+0.2269	+0.2214	+0.1947	+0.1549	+0.1097	+0.0665	+0.0312	+0.0080
50°	+0.0097	+0.0574	+0.0799	+0.0830	+0.0725	+0.0544	+0.0343	+0.0165	+0.0043
60°	—0.2146	—0.1389	—0.840	—0.0465	—0.0229	—0.0099	—0.0031	—0.0056	—0.0000
70°	—0.4628	—0.3561	—0.2654	—0.1898	—0.1286	—0.0805	—0.0445	—0.0195	—0.0048
80°	—0.7272	—0.5876	—0.4586	—0.3425	—0.2411	—0.1561	—0.0885	—0.0396	—0.099
90°	—1.0000	—0.8264	—0.6580	—0.5000	—0.3572	—0.2340	—0.1340	—0.0603	—0.0152
100°	—0.7272	—1.0652	—0.8574	—0.6575	—0.4733	—0.3119	—0.1795	—0.0810	—0.0205
110°	—0.4628	—0.7512	—1.0506	—0.8102	—0.5858	—0.3875	—0.2235	—0.1011	—0.0256
120°	—0.2146	—0.4394	—0.6865	—0.9535	—0.6915	—0.4589	—0.2649	—0.1150	—0.0304
130°	+0.0097	—0.1431	—0.3214	—0.5375	—0.7869	—0.5224	—0.3023	—0.1371	—0.0347
140°	+0.2033	+0.1397	+0.0334	—0.1202	—0.3238	—0.5777	—0.3345	—0.1518	—0.0384
150°	+0.3604	+0.3894	+0.3672	+0.2854	+0.1384	—0.0771	—0.3607	—0.1637	—0.0414
160°	+0.4761	+0.6022	+0.6698	+0.6672	+0.5854	+0.4189	+0.1655	—0.1725	—0.0437
170°	+0.5469	+0.7716	+0.9321	+1.0135	+1.0039	+0.8949	+0.6827	+0.3676	—0.0450
180°	+0.5708	+0.8925	+1.1461	+1.3138	+1.3809	+1.3367	+1.1750	+0.8948	+0.5000

TABLE III. OUTWARD DEFLECTION DUE TO TWO RADIAL OUTWARD FORCES

(Coefficients to be multiplied by $S \div \pi EI$, eq. 10)

ϕ	ϕ-90°	100°	110°	120°	130°	140°	150°	160°	170°
0	—0.4295	—0.4868	—0.4964	—0.4622	—0.3923	—0.2983	—0.1948	—0.0986	—0.0275
10	—0.4141	—0.4711	—0.4815	—0.4490	—0.3816	—0.2905	—0.1898	—0.0962	—0.0269
20	—0.3698	—0.4252	—0.4376	—0.4086	—0.3503	—0.2676	—0.1755	—0.0892	—0.0250
30	—0.3001	—0.3523	—0.3678	—0.3485	—0.3001	—0.2309	—0.1523	—0.0778	—0.0219
40	—0.2104	—0.2577	—0.2767	—0.2676	—0.2341	—18.26	—0.1219	—0.0629	—0.0178
50	—0.1079	—0.1485	—0.1705	—0.1725	—0.1563	—0.1253	—0.0856	—0.0450	—0.0130
60	—0.0023	—0.0331	—0.0567	—0.0698	—0.0716	—0.0627	—0.0457	—0.0253	—0.0076
70	+0.0969	+0.0791	+0.0562	+0.0335	+0.0146	+0.0016	—0.0045	—0.0049	—0.0020
80	+0.1791	+0.1781	+0.1593	+0.1301	+0.0913	+0.0634	+0.0355	+0.0152	+0.0035
90	+0.2337	+0.2537	+0.2437	+0.2123	+0.1680	+0.1185	+0.0717	+0.0335	+0.0086
100	+0.2537	+0.2964	+0.3006	+0.2729	+0.2234	+0.1629	+0.1017	+0.0490	+0.0130
110	+0.2437	+0.3006	+0.3222	+0.3051	+0.2578	+0.1928	+0.1230	+0.0605	+0.0164
120	+0.2123	+0.2729	+0.3051	+0.3035	+0.2666	+0.2052	+0.1340	+0.0671	+0.0185
130	+0.1680	+0.2234	+0.2578	+0.2666	+0.2463	+0.1974	+0.1327	+0.0681	+0.0191
140	+0.1185	+0.1629	+0.1928	+0.2052	+0.1974	+0.1678	+0.1183	+0.0629	+0.0180
150	+0.0717	+0.1017	+0.1230	+0.1340	+0.1327	+0.1183	+0.0901	+0.0511	+0.0154
160	+0.0335	+0.0490	+0.0605	+0.0671	+0.0681	+0.0629	+0.0511	+0.0327	+0.0109
170	+0.0086	+0.0130	+0.0164	+0.0185	+0.0198	+0.0180	+0.0154	+0.0109	+0.0047
180	.....	.....	.....	.....	.....	.....	.....	.....	.....

from the water pressure and from each pair of radial forces. The steps of this calculation have been tabulated in Table IV for 10° intervals, portions of Table I being repeated for the sake of clearness. In the table M_w and Δ_w represent the bending moment and deflection, respectively, due to the water pressure alone, and are taken directly from Table I; M_1 and M_2, Δ_1 and Δ_2 are obtained by multiplying the proper parts of Tables II and III by the values found for S_1 and S_2, and represent the moments and deflections produced by these forces. M_r and Δ_r are the resultants. All bending moment figures in Table IV should be multiplied by the constant γr^3, deflection figures by $\gamma r^5/EI$.

This example shows but one special case. Reactions for any width of saddle may be worked out in the same way, and as many forces chosen to represent the saddle reactions as may be thought necessary. Table IV is then computed with a corresponding number of columns.

It is worth noting that for saddles having a total central angle of much less than 80°, that portion of the pipe shell over the middle of the saddle tends to rise, and thus to leave the pipe supported only at the tips of the saddles. This shows that narrow saddles are

TABLE IV. RESULTANT BENDING MOMENTS AND DEFLECTIONS FOR PIPE SUPPORTED OVER 120° SADDLE, USING 5 CONCENTRATED REACTIONS

ϕ	M_w	M_1	M_2	M_r	Δ_w	Δ_1	Δ_2	Δ_r
0°	0.2500	0.0195	0.1593	0.071	0.2338	0.0297	0.1810	0.023
10	0.2387	0.0189	0.1539	0.066	0.2264	0.0290	0.1758	0.022
20	0.2054	0.0171	0.1379	0.050	0.2050	0.0268	0.1599	0.019
30	0.1526	0.0141	0.1117	0.027	0.1712	0.0232	0.1364	0.012
40	0.0841	0.0101	0.0762	0.002	0.1276	0.0186	0.1048	0.004
50	0.0051	0.0052	0.0325	0.033	0.0776	0.0130	0.0676	0.003
60	0.0785	0.0005	0.0182	0.060	0.0250	0.0068	0.0274	0.009
70	0.1595	0.0068	0.0743	0.078	0.0258	0.0007	0.0131	0.013
80	0.2309	0.0135	0.1341	0.083	0.0709	0.0054	0.0510	0.015
90	0.2854	0.0204	0.1958	0.069	0.1073	0.0110	0.0831	0.013
100	0.3160	0.0274	0.2374	0.031	0.1316	0.0155	0.1068	0.009
110	0.3165	0.0341	0.3172	0.035	0.1424	0.0188	0.1194	0.004
120	0.2819	0.0404	0.3733	0.132	0.1392	0.0204	0.1188	.....
130	0.2084	0.0461	0.2104	0.048	0.1234	0.0202	0.1044	0.001
140	0.0938	0.0510	0.0471	0.004	0.0977	0.0180	0.0804	0.001
150	0.0620	0.0550	0.1117	0.005	0.0662	0.0138	0.0524	.....
160	0.2574	0.0252	0.2612	0.029	0.0347	0.0078	0.0262	0.001
170	0.4885	0.1041	0.3968	0.012	0.0100	0.0024	0.0072	.....
180	0.7500	0.1792	0.5144	0.056	.....	.....	.....	.....

subject to heavy pressure at their tips, where most of the reaction is concentrated. As the width of support is increased, the pressure becomes more evenly distributed, but has a greater resultant moment about the center line of the saddle. All saddle reactions thus obtained are the greatest which can exist, since any movement of a support decreases the pressure against it. As the supports are assumed not to move, the saddle reactions do not depend upon the rigidity of the pipe shell.

It is believed that while this method may not lead to an exact determination of pipe stresses, owing to the neglect of tangential forces and deflections, it furnishes a rational basis for saddle design, and gives results which do not depend upon arbitrary assumptions of pressure distribution.

Duralumin Made Brittle by Corrosion

Sheets of duralumin used in aeroplane construction have been found to become brittle in service by the development of intercrystalline weakness or cracking. This action has been studied at the Bureau of Standards, and it is found that it can be produced either by corrosion alone or by corrosion and stress acting simultaneously. Both acid and neutral solutions displayed this effect, while alkalis did not. Annealing and cold rolling did not materially affect the corrosion.

Road Transport by Railways

(London Correspondence)

THE committee of eight, appointed by the British Ministry of Transport, "to enquire and report whether it is desirable that the railway companies should have general or limited powers to carry goods by road, and, if so, what, if any, conditions should be attached to the exercise of this power," has issued three separate reports. These are, briefly:

1. The railway companies have given assurances that they do not intend to obtain a monopoly of road transport by rate-cutting, but restrictions should be imposed which would make such action impossible. An objection to the granting of general powers to railway companies to carry goods by road is that the indirect effect would result in increasing the power of the railway workers' unions, and that, in the event of a railway strike, it would be more difficult for the government to organize road transport. The gist of this report is that railway companies should be given the right to run road services under certain restrictive conditions.

Traffic Diverted To Highways.

2. Although to some extent traffic has been diverted from the railway lines to the roads by means of independent carriers by road, that traffic in no sense belonged to the railway companies, but is the legitimate extension of the business of the old road haulage contractor. It is ancient history that the railways, by reason of the greater facilities they afforded, have diverted traffic from stage coaches and other horse-drawn vehicles and from canals. If the internal combustion engine as applied to vehicles running on the road does divert traffic from the railways, the companies are only suffering in their turn what happened to the stage-coach proprietor, road-haulage contractor, and the companies owning canals. In the view of the committee only those are entitled to traffic who can carry it in the best and cheapest way, and therefore the committee is not prepared to recommend that a railway company should begin, under the powers of an act of Parliament, an entirely new trade. "We are satisfied," the committee states, "that the haulers and the railway companies have resulted in benefit to the public. In our view, railway companies, if they are prohibited from carrying direct by road, would be induced by the competition of legitimate road haulage to give better facilities on the railways and to fix their rates at a reasonable level. If, on the other hand, they were allowed to carry on the trade of carriers by road, they would not have the inducement to do the best they possibly could with the railways."

3. The third report, which is signed exclusively by a prominent trades unionist belonging to the United Vehicle Workers and National Transport Workers' Federation, says: "I am not disposed to recommend that railway companies be given any further powers without their first proving, by the efficient application of their present power, that they are prepared to give the public better service. I am, however, in favor of granting powers to the railway companies to establish "test services" in agricultural or other sparsely populated areas, purely for development purposes." The gist of this report is that nationalization of all forms of transport is the only complete solution.

Railroad Ash-Handling Plant Has Buckets and Crane

Installation on Burlington Railroad Designed for Economical and Direct Handling From Pits to Cars

AN EXTENDED study was made of various types of pits and ash-handling devices in order to secure a plant which would give the most economical service and best meet local conditions where improved ash pit facilities were required at the engine terminal of the Chicago, Burlington & Quincy R.R. at Denver, Col. A compact arrangement was specially desirable on account of limited space. The arrangement selected, constructed along the lines of plants developed and built by the Buffalo, Rochester & Pittsburgh Ry., comprises a series of cast steel buckets placed in shallow pits to receive ashes directly from the locomotives. The buckets are handled by means of an overhead crane from the pit directly to the ash car, as shown on the drawings.

Two concrete ash pits, 72 ft. long, and a parallel ash car track are spanned by the 5-ton electric traveling crane, Fig. 1. The crane runway and supports are of timber construction, on creosoted piles and sills. The pits are of unusual shape, with sloping sides in the upper part and narrow rectangular lower portion, old 56-lb. rails being imbedded in the sloping surfaces with their bases projecting ½ in. from the surface of the concrete. Each parapet wall is capped by a 12-in. channel, to which the 85-lb. track rail is secured by clips and bolts.

The buckets, each with a capacity of about 2 cu.yd., are seated on the projecting rails of the pit walls. When all the buckets are filled the traveling crane is put into service to lift and carry them over the cinder car, where they are dumped automatically and then replaced in the pit. In dumping, the bucket opens at the bottom like a clamshell, the two halves being carried by a pair of scissors levers at the middle. When the loaded bucket is over the ash car it is raised to bring the horizontal arms of these levers in contact with a ring on a frame projecting below the crane trolley, as shown. With further hauling of the cable the lever arms are depressed and swing the bucket open. The

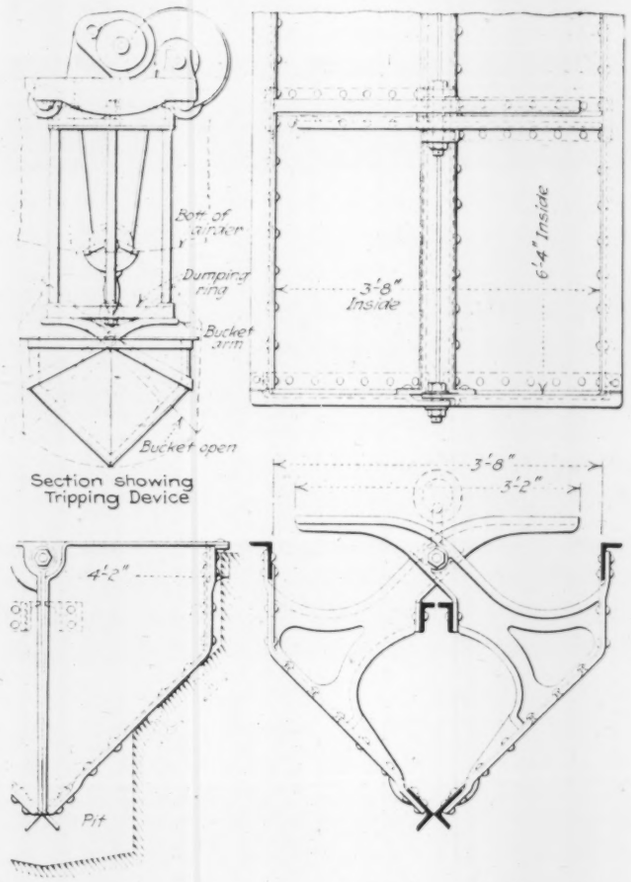


FIG. 2. BUCKET FOR RECEIVING LOCOMOTIVE ASHES

average time of emptying the buckets, or cleaning the two pits is 75 to 80 minutes.

About 45 engines have fires cleaned in the 24-hour period. Shoveling ashes from the pit directly into a car was the former method employed at this terminal, and the new installation has effected a material saving in labor. The design of this ash-handling plant was developed under W. T. Krausch, engineer of buildings; F. T. Darrow, assistant chief enigneer, and A. W. Newton, chief engineer, all of Chicago, Burlington & Quincy R.R.

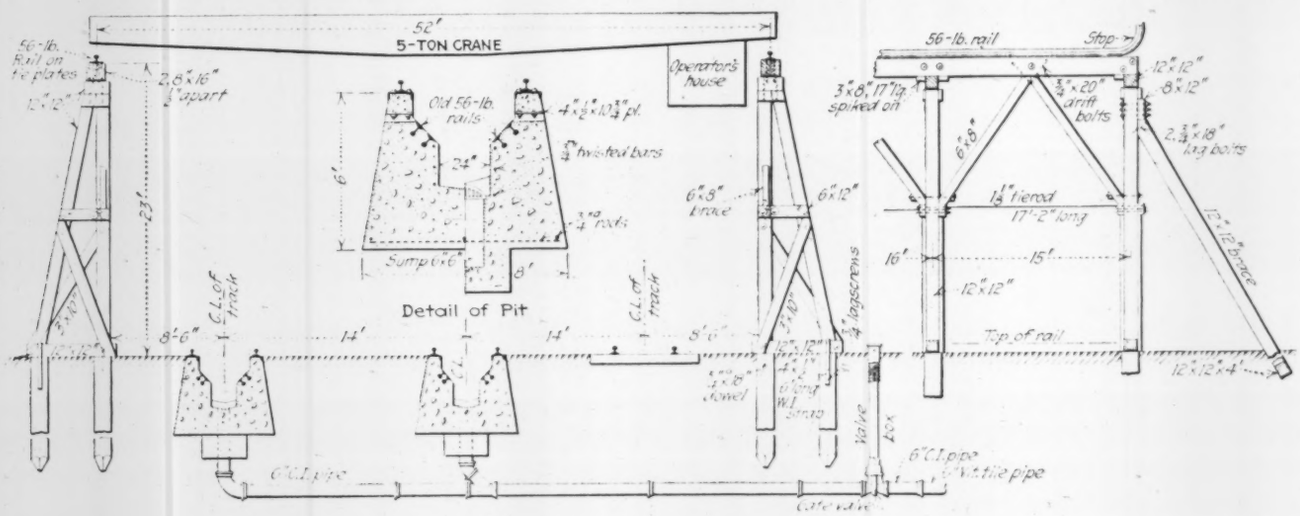


FIG. 1. ASH PIT WITH OVERHEAD CRANE

Nitrogen—with Special Reference to Activated Sludge

An abstract by Kenneth Allen, Sanitary Engineer, Board of Estimate and Apportionment, New York City, of a 54-p. monograph by Dr. Gilbert J. Fowler, entitled "The Conservation of Nitrogen with Special Reference to Activated Sludge," comprising the December issue of the "Journal" of the Institute of Science, Bangalore, India (rupees, 2-8-0).

DR. GILBERT J. FOWLER, formerly chemist of the sewage-works of Manchester, England, but for some time professor of chemistry of the Indian Institute of Science at Bangalore, India, has published a monograph, "The Conservation of Nitrogen with Special Reference to Activated Sludge," which deserves the careful attention of engineers and scientists interested in the subject. As clearly set forth by Dr. Fowler, the nitrogen problem is one of fundamental importance; in fact, "*the most important problem confronting the human race.*" For even before the supply is exhausted the poverty and distress occasioned by lack of nitrogen as a fertilizer will result in such stress of competition as may explode in war.

As early as 1898 Sir William Crookes pointed out the necessity of increasing the wheat yield per acre and of conserving the nitrogen now lost in sewage and other wastes.

There are three available sources of nitrogen upon which to draw: (1) *Atmospheric Nitrogen*, of which there is a sufficient amount over each square mile of the earth's surface to supply the world's present requirements for 20 years. (2) *Nitrates*, of which the largest source available is some 500,000 tons per annum of Chili saltpeter.

(3) *Organic Nitrogen*, or that recoverable (a) as ammonia from coal, peat or silt; (b) slaughter house refuse; (c) fish meal; (d) animal refuse—leather, bones, hoofs, etc.; (e) green manures; (f) oil cake; (g) animal manure, including 10,000,000 tons of guano recently discovered near Campeche, Mexico; (h) town sewage.

Assuming Rubner's figure of 1.4 grams of nitrogen of fecal origin per capita per day, the world's supply is estimated at 500,000 tons per annum, or, from a total of 8,000,000 tons of solid and liquid excreta, a supply of 1,300,000 tons per annum.

As an illustration of the value of this nitrogen Dr. Fowler mentions the fact that the City of Shanghai received £40,000 per annum from contractors for its nightsoil. In addition to this payment the contractors maintain an army of coolies and a fleet of nightsoil boats. But the method of utilizing the nitrogen of nightsoil by direct application to the land is inadmissible in a society with the ideas of decency that exist in America and Western Europe. How, then, may the products of sewage treatment be utilized by the recovery of this nitrogen content?

Comparing the sludges for different processes we find the following:

PERCENTAGES OF NITROGEN IN VARIOUS TYPES OF SEWAGE SLUDGE. (CALCULATED ON SLUDGE DRIED AT 100 DEG. C.)

Source		Percentage
Sedimentation tanks	Manchester	3.32
	Lawrence	2.37
Chemical precipitation	Dorking	0.89
	Glasgow	1.30
Septic tanks	Manchester	2.30
	Lawrence	2.30
Activated-sludge process	Manchester	....
	Withington Works	7.09

The activated-sludge process—which, by the way, was first suggested and developed by Dr. Fowler—is seen to furnish a product particularly rich in nitrogen, containing even more than the crude sewage. This is due to the action of nitrifying bacteria that are cultivated in the sludge and which cause fixation of nitrogen from the atmosphere. Furthermore the effluent is also rich in nitrates that may be utilized in agriculture by irrigation.

At Withington, Manchester, with a dilute, domestic sewage, the yield was about 500 tons per annum per million inhabitants, a figure almost identical with the estimated demand of that population. So that, without the sacrifice of sanitary or esthetic requirements, a population may be practically sustained by the nitrogen it produces.

The availability of the nitrogen of activated sludge for plant growth demonstrated with such favorable results by Bartow and Hadfield at Urbana, Ill., has been confirmed by Arden at Manchester and by Nasmith and McKay at Toronto. To conserve the entire supply, however, the ammonia and nitrate in the effluent must be utilized, and this may be done either by irrigation of crops or by the culture of fish, as practiced in many places in Austria and in China. The rapid nitrification produced by activated sludge suggests to Dr. Fowler the possibility of producing similar results on ammonium salts available from coal, peat and other substances, and this, with the prevention of nitrogen losses, is a broad subject that is being further investigated.

The fixation of atmospheric nitrogen has received much attention, especially during the war. In the arc process "the oxygen of the air is caused to combine with nitrogen in a high tension electric arc with formation of oxides of nitrogen which are afterward absorbed by water to form nitric acid of 33 per cent strength." This action undoubtedly occurs through the influence of lightning. "It consumes 10.5-hp. years of electrical energy per ton of nitrogen fixed as nitric acid per annum."

The cyanamide process consisting of the formation of calcium carbide by the application of heat to lime and coke, its combination while hot with nitrogen, decomposition by steam under pressure with release of ammonia and the oxidation of the latter to form nitric acid. This required 2.5-hp. years per ton of nitrogen as nitric acid.

Lastly there is the Haber process, requiring 0.5-hp. years, and the cyanide process, which may be termed "thermo-chemical."

The world's production by fixation in 1917 was:

	Tons
Arc process	31,000
Cyanamide	200,000
Haber	114,000
Sundry	39,000
Total	384,000

Regarding these it may be observed that all require high temperatures and high initial and operating expense, while the total product is insignificant when compared with the 8,000,000 tons of nitrogen in the world's excreta.

There remain, however, various ways by which nitrogen fixation occurs through biological action. In 1885 Berthelot suggested this action by bacteria in the soil and three years later it was confirmed by Hellriegel and Wilforth. The chief of these nitrogen fixing bacteria are the *Azotobacter* and *B. radicicola*, the former thriving best on mannite, the latter on maltose, but the best results are reached by the two working by symbosis on dextrin.

Among other things heat has been shown to contain substances that stimulate plant growth termed *auximones*. These are produced by bacteria working on organic matter, rendering it available for plant life, and assisting in the production of the better known vitamines, which are an important ingredient of animal food. It is believed that the bacteria in activated sludge may produce auximones and that it is for this reason that this material shows a superiority to other manures.

Experiments at the Frankland laboratory at Manchester by Mumford and Gaul show a marked increase in the nitrogen of activated sludge over that in the sludge of the raw sewage, due in part to coagulation of colloids, but also to absorption from the air, and these have been confirmed by Sarangdhai and Nayak under Dr. Fowler's direction at the Indian Institute of Science. "The extent to which this fixation can be carried and the conditions of its maximum efficiency have yet to be determined."

From a review of all the evidence Dr. Fowler draws the following conclusions:

1. By scientific and economic use of waste material the nitrogen necessary for the world's agriculture can be readily supplied.
2. Very large populations in China and elsewhere are already adequately supplied without the need of artificial fertilizers.
3. Inorganic nitrogen in the form of nitrate, sulphate of ammonia or calcium cyanamide is not alone adequate for plant growth.
4. Auximones are necessary for vigorous plant life.
5. These are only found in organic manures.
6. Of these, *activated sludge* has given the most striking results.
7. If properly utilized this process offers the recovery of all the nitrogen in town sewage.

In order to obtain the best results further research is required in the form of laboratory, field and technical experiments, the suggested details of which are outlined.

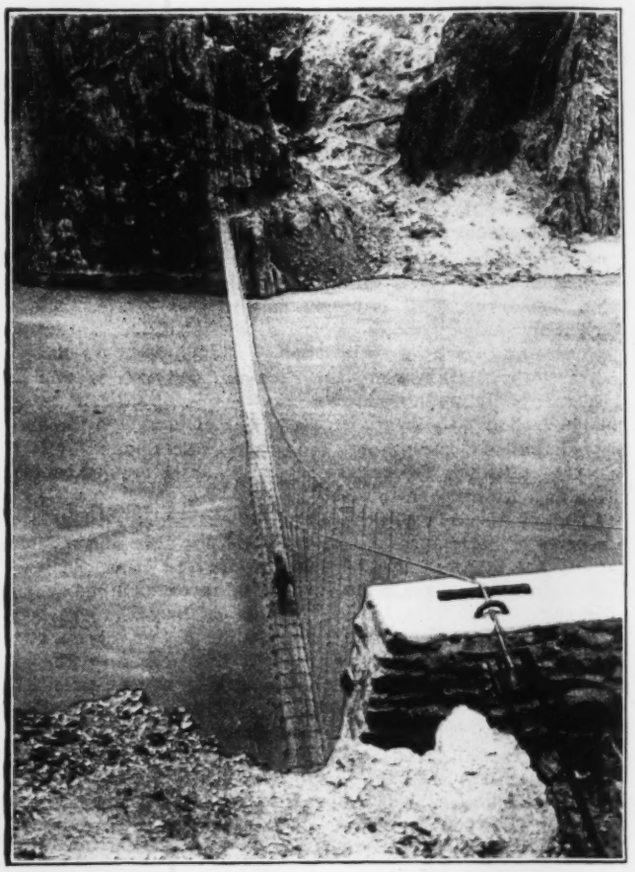
Bridge Across Colorado in Grand Canyon Completed

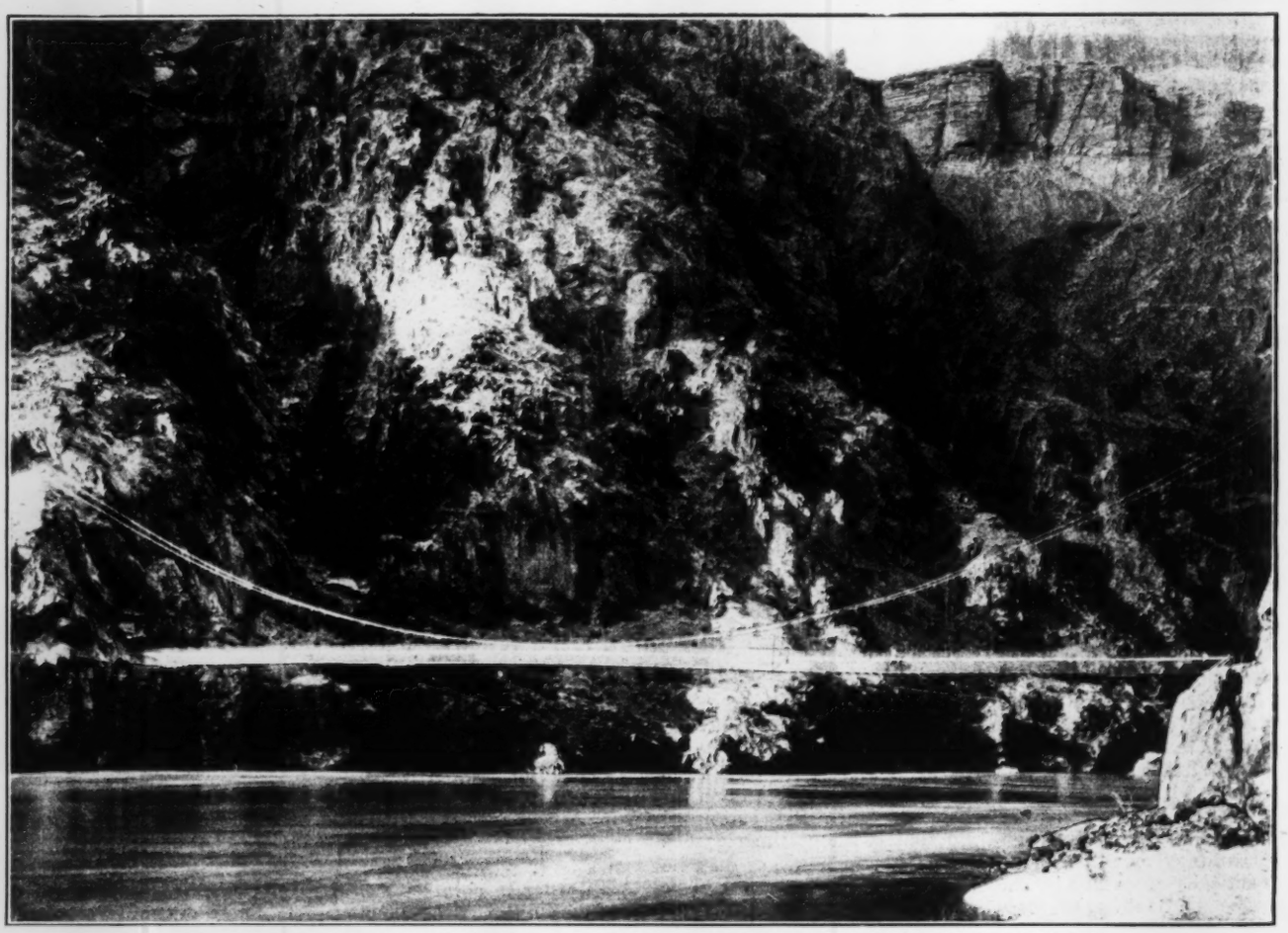
THE views on this page show completed the 500-ft. suspension bridge across the Colorado River in the Grand Canyon, the design of which was described in *Engineering News-Record*, Feb. 10, 1921, p. 254. The smaller view to the right is down the north anchorage toward the south side of the river; the larger view below is looking upstream from the left, or south, bank. D. L. Reaburn, superintendent of the Grand Canyon National Park, and the engineer who supervised the construction of the bridge, writes as follows.

The bridge was completed and opened for travel on May 15. No difficulty was experienced in getting horses and mules to cross. At first the animals were somewhat skittish about starting onto the bridge, but they soon became accustomed to it.

The cost of the bridge including the approach trail was about $17,000. The total amount of material packed into the canyon including camp equipment, supplies, forage and bridge material was about forty-five tons. The pack train was running continuously from Dec. 15, 1920, to May 15, 1921. The period of bridge work was from Feb. 1 to May 15, work during the previous six weeks having been on the building of a trail two miles in length from top of the Granite Gorge to the river.

The problem of transporting the main cables was solved by packing 200 lb. of cable on a mule at each end, and the intervening 300 ft. of cable was carried by 15 men, carrying a weight of about 35 lb. each, spaced at a distance of 20 ft. The only trouble encountered was to prevent the cable from throwing a kink in rounding the sharp turns in the trail.





SUSPENSION BRIDGE ACROSS COLORADO RIVER AT BOTTOM OF THE GRAND CANYON

The eleven miles from rim to river were covered in five hours.

Already rim to rim travel has increased—and when the Kaibab Trail up Bright Angel Creek is improved, and telephone communication established (which will be done next fall and winter) the bridge will supply a long felt want for crossing the canyon. The north rim country known as the Kaibab Forest, contains the largest undeveloped tract of timber in the United States, and probably the largest herd of deer, estimated at fifteen to twenty thousand. When railroad communication to the north rim his been established by the construction of a railroad from some point on the Salt Lake in Utah, the north rim will become one of the greatest summer recreational grounds in the United States, and with a commercial rim-to-rim aviation service it will be possible for the transcontinental traveler to route over the Union Pacific via Grand Canyon, completing the journey over the Santa Fé, or vice-versa.

The official name of the bridge is the Kaibab Suspension Bridge, and the rim-to-rim trail is known as the Kaibab Trail.

Progress Made in Federal Water Power Development

UNDER date of July 8, 1921, the Federal Power Commission has issued a statement of the progress made in the first year of operation of the Federal Water Power Act of June 10, 1920. An abstract follows:

Up to June 30, 1921, there had been filed with the Commission 229 applications aggregating 14,675,000 hp. and affecting 33 states, the District of Columbia, and Alaska. This amount is 75 per cent greater than the entire water-power development of the United States today. It is 50 percent greater than the combined water-power resources of Norway and Sweden, and considerably in excess of the combined resources of France and Italy. It is five times greater than the aggregate of all applications filed with the federal government in the preceding 15 years. The projects applied for vary in size from less than 100 horsepower up to the three million horsepower scheme of the Southern California Edison Co. on Colorado River.

Although the commission has been obliged to work under serious handicap, it has nevertheless accomplished many things in the first year of its operations. The law under which it acts is complicated, and great care has been necessary in the preparation of rules and regulations for its administration. The first ten regulations, covering the requirements for applications, were issued on September 3; the remaining ten, covering maintenance and operation of project property, rental charges, depreciation and amortization reserves, allocation of earnings, and accounts and reports were first issued on February 28 and later revised and reissued on June 6.

The issuance of permits and licenses necessarily awaited the approval of the regulations. The first license was issued on March 1 to the Niagara Falls Power Co. Between that date and July 1, final action has been taken on 47 applications, 13 preliminary permits have been issued, involving 1,075,000 hp., and 15 licenses, involving 757,000 primary horsepower and 460,000 secondary horsepower, or a total of 1,217,000 hp., making an aggregate of 28 projects, involving 2,292,000 hp., or as much as was issued by all of the executive departments during the 10 years preceding the passage of the federal Water Power Act. There were also pending on June 30 for final action at the next meeting of the commission 16 applications, involving 190,000 hp.

Only 60 per cent of the applications filed with the commission have been accompanied by sufficient information to warrant more than preliminary action. Seventy-five per cent of them have been advertised in local newspapers, as required by the Act, and an equal number have been submitted to the field for examination, hearing, and report by the several departments. A draft of a system of accounting has been prepared, following as closely as the requirements of the Act will permit the uniform system proposed by the National Association of Railway and Utilities Commissioners. The commission has also instituted investigations of Deschutes and Columbia Rivers as a preliminary to action upon applications for power sites on those streams. It has handled scores of applications for restoration to entry of lands in powersite reserves and has passed upon many legal questions involving the interpretation of the Act. It has been unable to make any of the valuations required by the Act.

The Commission realizes that there is no possibility of immediate development of all the projects applied for. The market could not absorb the power even if its construction could be financed. It does expect, however, that a progressive development of water powers will be undertaken as rapidly as financial conditions and market requirements will warrant. It believes that the Act is workable, and that its provisions will not interfere with the financing of legitimate undertakings,—an opinion which is confirmed by the national association of the electric-power industry. In fact, projects involving hundreds of thousands of horsepower and tens of millions of dollars are now being constructed under licenses issued by the commission. The chief present defect in the Act is its failure to provide adequate means for its expeditions administration.

New Division of Sanitation, New York State Department of Health

THE newly created Division of Sanitation of the New York State Department of Health, which on July 1 succeeded the Division of Sanitary Engineering, has a personnel made up from that of the old division. Except as to passing on plans for sewerage and sewage disposal the new division has substantially the same duties as the old one.

C. A. Holmquist, principal assistant engineer of the old Division of Sanitary Engineering, is director of the new division of Sanitation, and the following named assistant engineers in the old division have been transferred to the new division with the title of assistant sanitarian: Earl Devendorf, W. W. Young, Alfred Mullikin and A. I. Howd.

The activities of the Division of Sanitation, as outlined for *Engineering News-Record* by Dr. John A. Smith, secretary, State Department of Health, are as follows:

1. General supervision over sanitary quality of some 550 public water supplies, including field investigations, analytical studies and reports.
2. Enforcement of rules and regulations enacted by the Department for the protection of drainage areas of some 90 public water supplies.
3. Preparation of permits for the discharge of wastes, sewage and sewage effluent from municipalities, industrial establishments and public institutions.
4. Examination and approval of plans for the work of the Nassau County Mosquito Extermination Commission.
5. Investigation of major public nuisance.
6. Special investigations ordered by the Governor under Section VI. of the Public Health Law.
7. Investigations and studies of stream pollution and operation of water and sewage disposal plants.
8. Examination and reports of sanitary condition of construction, equipment and operation of milk pasteurization plants.
9. Special investigation of sanitary conditions of parks, fair grounds, camps and other public gathering places.
10. Examinations and reports of the sanitary conditions of state institutions.
11. Investigation of typhoid fever and other water-borne epidemics.
12. Advice to municipalities, corporations and individuals upon sanitary matters, including water supply, garbage disposal, plumbing, ventilation, drainage, etc.
13. Furnishing data to Surgeon-General of United States Public Health Service regarding water supplies used by common carriers in interstate traffic.

Large Apparatus for Tests of Lateral Earth Pressures

Measures Pressure Against 6-Ft. Retaining Wall—Test with Sand Gives Satisfactory Check on Theory

By G. M. Braune and Jacob Feld

Professor of Civil Engineering and Fellow in Civil Engineering, University of Cincinnati

SINCE the days of Vauban, the French military engineer who, 200 years ago, laid the foundations for Coulomb's theory of lateral pressures, engineers have been handicapped by lack of experimental data in designing retaining walls, bins, grain elevators, etc. An attempt to establish a correlation between the present earth-pressure theories and the actual existing pressures, and to afford the engineering profession a certain confidence in the design of retaining walls, has resulted in the construction of an earth-pressure apparatus on the campus of the University of Cincinnati, in size much larger than any ever tried before. The free-gate arrangement used is the same as employed in 1906 by Müller-Breslau. The design of the apparatus was conceived by G. M. Braune and C. C. Myers (one time Professor of Industrial Engineering, University of Cincinnati); the details of the design have been worked out by the fellows of the civil engineering department, namely, B. H. Wulfkoetter (1916-17) and Jacob Feld, the latter being responsible for completing the present design, installing the apparatus successfully, and carrying out the tests presented in this article.

The method of obtaining the pressure of earth (or any other granular material) is to measure the horizontal and vertical components of the action of the filling material upon a "free body." A wooden wall, 5 ft. wide and 6 ft. high, fits into the open front of a concrete bin, 5 ft. wide and 9 ft. long, 6 ft. high at the front and 12 ft. high at the rear. The wall is supported by two vertical rods, which rest directly upon 2,000-lb. Fairbanks platform scales. Any vertical force acting on the wall is directly transmitted to the scales and is registered. The horizontal thrust of the earth against the wall is measured by three horizontal struts, one at the top in the center of the width, and one at each of the lower corners. These struts, by rocker-arm arrangements, transmit the pressures directly to 1,000-lb. scales. In this transmission of pressure, the amount is reduced to half its real value. The three horizontal contacts give a stable support and approximately equal scale readings (with full bin), which tends to keep the apparatus in adjustment and equalize strain in the different parts. From the individual scale readings the amount, direction and point of application of the resultant pressure can be computed. The various parts are designed to keep deflections and deformations at a minimum under maximum loading.

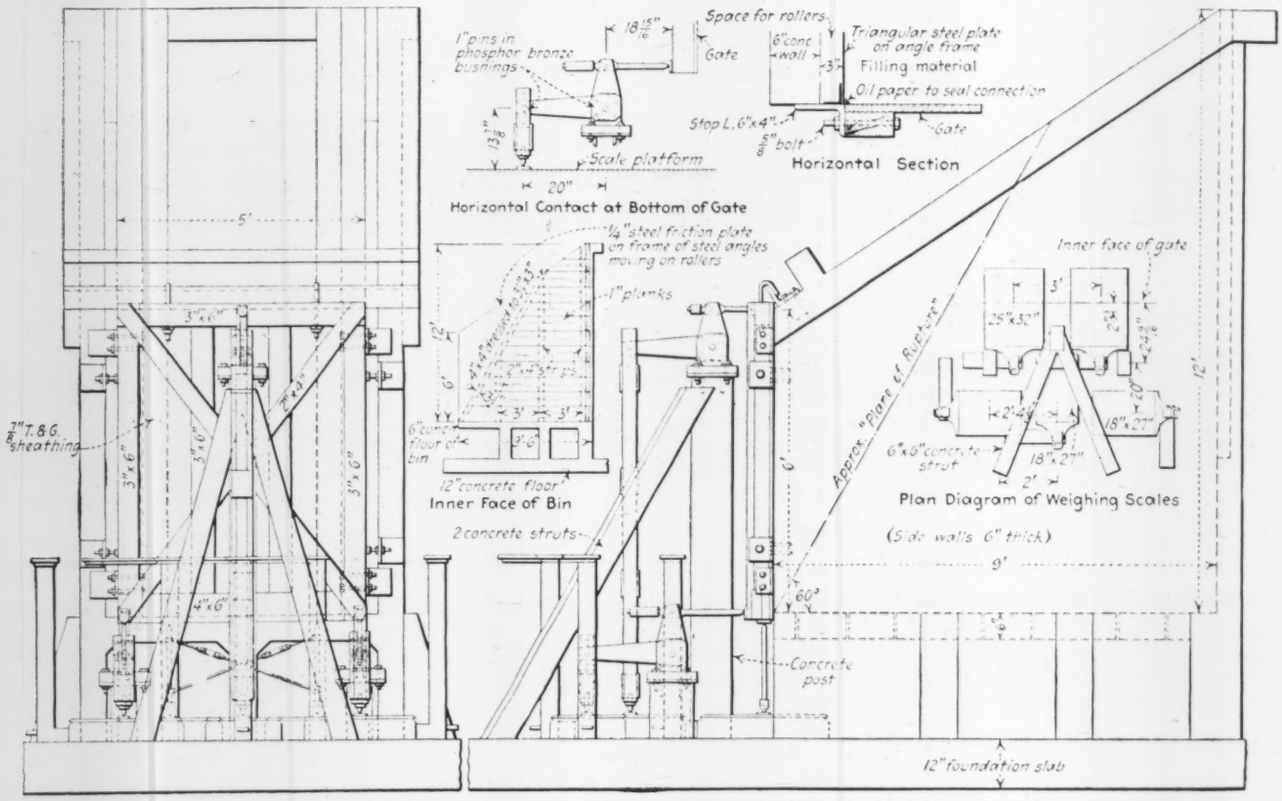


FIG. 1. ELEVATIONS OF TEST APPARATUS, AND ESSENTIAL DETAILS

Previous experimenters on such earth pressure have shown the importance of reducing the movement of the test wall under action of the pressure. They also experienced difficulty in sealing the joint between wall and bin, without introducing friction. These points received special study in the design of the present apparatus. To reduce the movement of the wall to a minimum, stops were placed on the scales to limit the range of movement of the scale beams. A range of 1/40 in. was at first provided, but later a range of 1/20 in. was found most satisfactory, since it made reading of the scales easier. With the 1/20-in. play of the weighing beam, the platform of the scale moves 1/2,000 in., since the lever ratio of the scales is 1:100. This is the maximum vertical displacement or possible motion

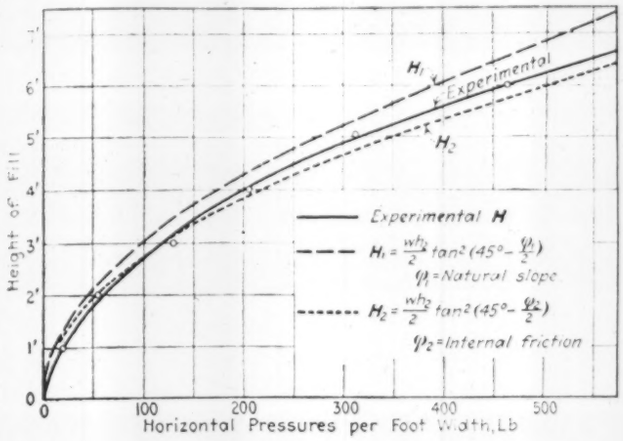


FIG. 2. TEST CURVE FOR SAND AND TWO THEORETICAL CURVES

of the wall. The horizontal motion of the wall is limited to 1/4,000 in., by virtue of the bell-crank multiplication.

The inside face of the free wall is in the same vertical plane as the front edges of the bin sides (see detail in Fig. 1). Thus a close joint is obtained without friction; leakage is prevented by a strip of thin oiled paper in the corner. Short steel angles fixed to the wall and bearing against the bin prevent any motion of the gate toward the bin or *against* the filling material. Lateral displacement of the gate is prevented by angles fixed to the bin.

The retarding effect of the side walls has always introduced an element of uncertainty into earth pressure measurements of this kind. Winkler (1871) used a thin partition wall in the center of his bin, parallel to the sides; thereby getting four friction losses. Without the partition he gets two friction losses and so determines the value of each retarding force. This method has been shown to be inaccurate. Müller-Breslau (1906) states that some correction must be made in his results to take this loss in pressure into account, but does not try to evaluate it. In this apparatus the friction between the filling material and the side walls is eliminated. The part of the earth which tends to slide (wedge of rupture) is a triangular prism, since the surface of rupture is approximately a plane. The sides of this prism are in contact with two stiffened steel plates, to each of which are fastened three rollers (on phosphor-bronze bushings). The rollers bear on the inside face of the concrete side walls, on polished surfaces. The side walls below and back of these steel triangles are faced with timber, so that the clear width of the finished bin is 5 ft. at all points. A thin strip of oiled paper covers the joint between the timber and steel plates, keeping out the filling material from the cracks. The steel triangles are exactly counterbalanced vertically. The filling material binds against these plates, and any tendency for the wedges of rupture to separate from the rest of the filling material will cause a movement of the steel plates, thus eliminating the side-wall action, except the friction in the rollers, which, however, can be determined but is small. The effect of the side-wall friction can be determined by running a set of tests with these plates fixed to the side walls.

Method of Operation—Before any filling is placed in the bin, the riders are run out on the scale beams, so that the beams will always be down. The reading on the scales will at all times be in excess of the contemplated active earth pressures; the wall is prevented from moving into the bin by the bearing angles. Then, by moving the riders and allowing the beam to float, we will get active and not passive pressures. In this manner we are also able to eliminate the deformation in the struts, and the scale movements recorded represent the actual movements of the wall. By changing the positions of the stops we are able to control the amount of movement of the wall.

An extensive set of experiments has been outlined. It is intended to conduct tests on various materials, under different conditions, as to methods of filling, moisture content, surcharge, etc., acting upon various walls. The inclination of the wall can be easily changed; by attaching a triangular prism, we can have a back face which slopes forward or slopes backward.

Tests with Sand—The following is a part of some of the tests which were made on the material excavated from the Cincinnati subway cut on Canal St.

The material is sand, containing about 3 per cent of clay, 9.4 per cent of water, and weighing 100 lb. per cu.ft. Specific gravity is 2.64. A mechanical analysis shows 8 per cent retained on the ¼-in. sieve, and 62 per cent passing the 28 sieve. The angle of natural repose was 40 deg. The angle of internal friction was 34 deg., found by actual experiment.

The angle of friction between the sand and the dry wood of the wall was 26 deg. The angle of friction

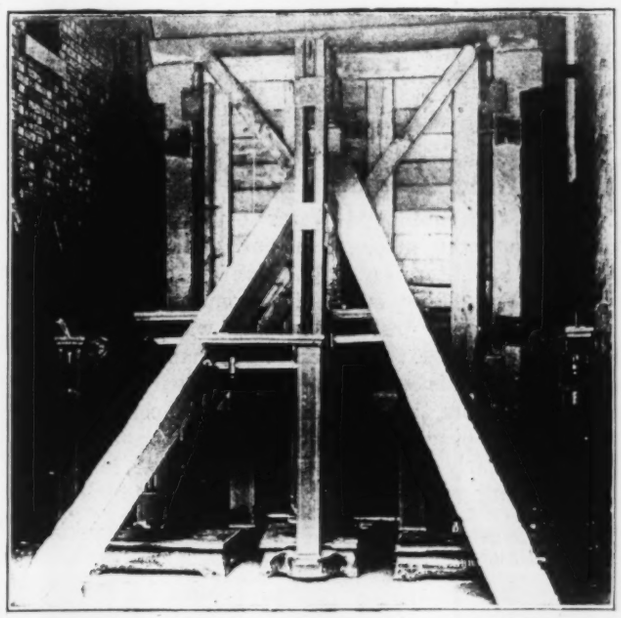


FIG. 3. FRONT VIEW OF BIN AND WEIGHING SCALE

between the sand and the wet wood of the wall was 31 deg. When the bin was emptied, it was noticed that the wood was wet, and the angle of action of the resultant (ϕ') should be 31 deg. Readings were taken for every 3-in. increase of fill, the material being shoveled in horizontal layers. A few of the readings are given below. The tabulated quantities are defined as follows:

h = height of fill, feet;
$P = \sqrt{H^2 + V^2}$, total pressure per foot width;
H = horizontal component per foot width, pounds;
V = vertical component per foot width, pounds;
ϕ' = angle of inclination of the resultant from the normal to the back of the wall; $\tan \phi' = V/H$;

x = height of point of application above the base of the wall = $\frac{H \text{ top}}{H \text{ total}} \times 6$ ft.;

x/h = ratio of height of the point of application of the resultant to total height of fill;

H_1 = theoretical horizontal component from formula $H = \frac{1}{2} wh^2 \tan^2(45^\circ - \frac{1}{2}\phi)$;

w = weight per cu.ft.;

ϕ_1 = angle of natural slope (40 deg., as determined for this material);

H_2 = same as H, where

ϕ_2 = angle of internal friction (34 deg., as determined for this material).

h	P	H	V	ϕ'	x/h	H_1	H_2	disregard values for 1 ft.
1 ft.	21 lbs.	20 lbs.	5 lbs.			11 lbs.	14 lbs.	
2	62	54	32	30° 50′	425	44	56	
3	151	130	77	29° 55′	351	98	127	
4	242	205	131	32° 50′	358	174	226	
5	370	312	198	32° 20′	360	272	352	
6	545	464	285	31° 30′	365	393	507	

The curves reproduced in Fig. 2 herewith show the relations between H, H_1, and H_2. The readings constitute an average between three sets obtained under the same conditions. The readings checked very closely, especially for fills over 3 feet.

Conclusions—For this case, horizontal fill and vertical wall, the curves show that the formula may safely be used, if ϕ is taken as *the angle of internal friction*. For this special case, Coulomb's and Rankine's theories give the same formula, but both used the angle of natural slope. Further experiments showed that the maximum pressure occurs just after filling, and slowly decreases as the fill settles. The above readings are the maximum values, obtained just after filling.

Water Treatment Plants in Iowa

Out of 475 municipal water plants in Iowa less than three dozen attempt to purify the water. At twenty plants filters or coagulation and sedimentation basins exist. There is one iron-removal plant and a dozen chlorination installations for water from wells or infiltration galleries. Jack J. Hinman, Jr., bacteriologist and chemist of the Iowa State Board of Health, in a paper before the Iowa Engineering Society, stated that samples examined by the State laboratory indicate that nearly every plant has given at least one unsatisfactory result during the period 1914 to 1920.

BACTERIAL RESULTS FROM IOWA PURIFICATION PLANTS, 1914-1920

City	Number Samples	Number Bad	City	Number Samples	Number Bad
Burlington	549	23	Fort Madison	13	5
Cedar Rapids	13	5	Iowa City	2,364	15
Centerville	57	7	Keokuk	101	17
Chariton	12	4	Lenox	8	4
Council Bluffs	6	1	Oskaloosa	5	0
Creston	30	5	Ottumwa	8	1
Davenport	28	4	Stormlake	16	6
Fairfield	12	2			

It is his opinion that unless effluents are watched daily so as to provide some way of quickly spotting inadequate treatment, unsatisfactory water may be supplied for long periods. Daily analyses are made at Des Moines, Cedar Rapids, Council Bluffs, Davenport, Iowa City and Oscaloosa. Frequent analyses are made of the supplies at Burlington and Keokuk.

The accompanying table gives the details of bacterial sampling in fifteen of the cities where investigations were made.

Tests on Built-Up Timbers

PROGRESS reports are now available of the strength tests of built-up southern yellow pine timbers made at the Forest Products Laboratory, Madison, Wis. In tests on 11 built-up beams it has been found that there is no marked difference between built-up beams of "dense" material practically free from defects and solid beams of "dense" material with defects limited as in the select structural grade of the Southern Pine Association. Advantages of built-up beams consist in the utilization of smaller stock, quick and easy seasoning, availability and the possibility of avoiding bad checks, shakes and other defects. The tests were made at the Forest Products Laboratory in co-operation with the National Lumber Manufacturers' Association by G. E. Heck, engineer in forest products.

Each built-up beam consisted of five 2 x 12-in. planks 16 ft. long bolted together. The planks composing a beam were matched by comparing ends, material of practically the same quality being used in each beam, and were surfaced on both sides in order to have the resulting beams of uniform dimensions and all planks fitting closely together. After the built-up beams had been tested, small clear test specimens called "minors" were sawed from each plank in the beam near the point of failure and tested according to the laboratory's standard method for testing small clear specimens. The nominal sectional dimensions were 1.6 x 2 in.

The ratio of the modulus of rupture or maximum fiber stress of the built-up beams to that of the small test specimens was 72 per cent, while the same ratio for the solid beam was 66.3 per cent, based on average values. The ratio of the modulus of rupture of the built-up to the solid beams was 107 per cent.

The modulus of elasticity of the built-up beams was 16.2 per cent higher than the average of the small test specimens, while for the solid beams this value was 17.8 per cent higher.

As a rule the stiffest plank in a built-up beam takes the largest share of the load and the planks of lesser stiffness receive proportionately smaller shares. The stiffness, or modulus of elasticity of the planks in a built-up beam may vary under extreme conditions more than 100 per cent of the lowest value.

The large number of tests made at the laboratory on small clear specimens has shown that a piece of high modulus of elasticity normally deflects farther at the elastic limit and at maximum load than a less stiff piece. This being true, it is apparent that the built-up beam is most likely to fail in a plank of low modulus of elasticity rather than in the stiffer plank even though the latter carries a larger share of the load. This, however, is not true of defective material, for the first failure will usually occur in the most defective timber. The strength of the built-up beam depends upon the deflection the defective piece takes at failure.

The Forest Products Laboratory has made no tests with defective built-up beams to ascertain if the defects in the component planks can be staggered in the beam and the latter so fastened together that results will be comparable to results on solid beams containing the same number and size defects similarly located. Neither have any tests been made to determine if laminations will act independently as individual beams, each breaking at its particular defect, the net results being practically equivalent to having all the defects at the same point in a solid beam.

Short Courses in City Planning in California

Friday and Saturday evening lectures on city planning, to extend through six weeks, were begun at Sacramento in May, under the auspices of the University of California Extension Division and the California Real Estate Association. Other short courses in city planning were proposed for San Francisco and Oakland and have already been given in Los Angeles.

Fence of Wire Cloth Retains Hydraulic Fill

Steel Pile Cofferdam, 900 x 750 Ft., Built Within 1,000 x 918-Ft. Bulkhead for Milwaukee Sewage Works

By R. R. Lundahl
Division Engineer, Milwaukee Sewerage Commission, Milwaukee, Wis.

A FENCE of ¾-in. and ½-in. wire cloth held to shape successfully a long narrow fill recently made by a hydraulic dredge in connection with the construction of the new sewage works at Milwaukee, Wis. Whereas a board fence was repeatedly undermined and torn out, the wire fence let the water through and still retained the solids because of the porous mat of light material formed against the close mesh.

As indicated by Fig. 1, a reclaimed area about 1,000 x 918 ft. off the east shore of Jones Island, is the site of the new sewage works. The contract provided for building approximately 1,800 lin. ft. of pile bulkhead filled with stone; for driving 2,400 lin. ft. of steel sheetpile cofferdam, and tie piles to support the same, including batter piles; for placing all tie rods and cables; for excavating within the cofferdam to an elevation of 12; and for placing the excavated material between the pile bulkhead and the steel sheet piling.

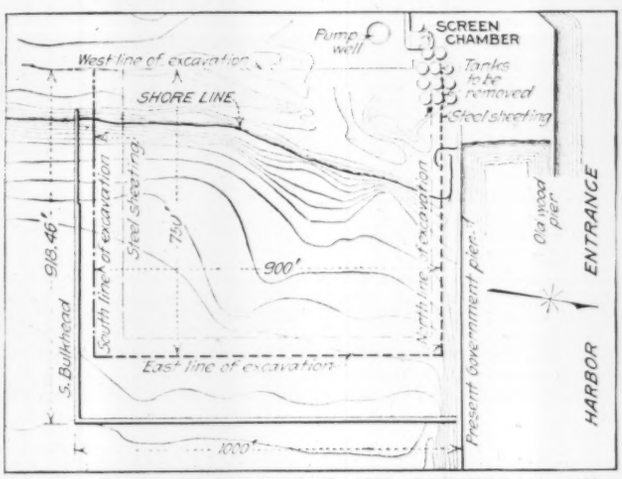


FIG. 1. PLAN OF BULKHEAD AND COFFERDAM, MILWAUKEE SEWAGE WORKS

A hydraulic dredge, having a 24-in. discharge excavated the material. Necessarily a very large amount of water was discharged with the solid materials, and this water washed the fill so that it could not be retained above the top of the pile bulkhead, and from there it took a slope down to the top of the sheet steel piling and spilled over into the cofferdam.

A solid board fence, heavily braced was first built 30 ft. back from the steel sheeting and parallel to it, along the entire east side. The theory was that this fence would impound the water and allow the solid particles to settle out, the water flowing over the top of the fence. This proved to be a costly failure; instead of spilling over the fence the water worked its way underneath, and in a very short time the fence, bracing and all, was washed out. The fence was rebuilt several times, with different bracing, but always with the same results.

In place of using boards it was suggested that the fence be built of heavy wire cloth. The contractors regarded this plan skeptically, but after persuasion finally agreed to try it. The fence boards were removed and 24-in. wire cloth of ¾-in. and ½-in. mesh (galvanized) was substituted.

The theory of this construction was that there was enough light material, such as grass, cinders, sticks and bark, which would not pass through the cloth, to form a barrier for the heavier materials but still allow the water to pass through.

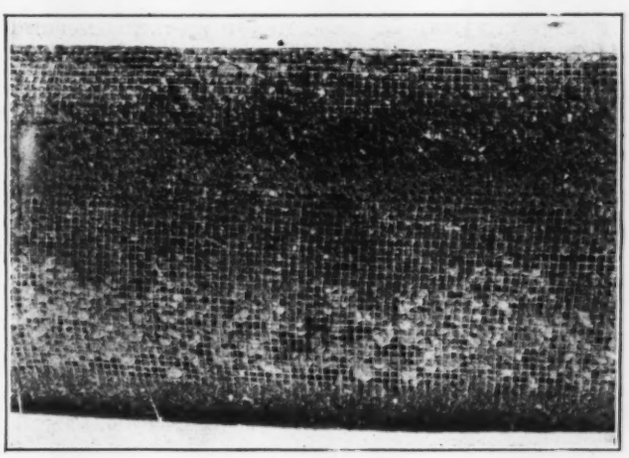


FIG. 3. VIEW OF BARRIER MAT ON WIRE FENCING

The fence worked exactly as had been expected. The water always carried enough lighter materials to form a barrier mat on the fence, in fact there was enough to keep the "scum" on the fence about 6 in. above the solid materials. The water passed through the scum and the wire cloth very nicely, whereas the heavier materials were settled out on the fill as desired. Scarcely any of the coarser sand or dirt passed through the fence, in fact only the very finest particles of sand escaped.

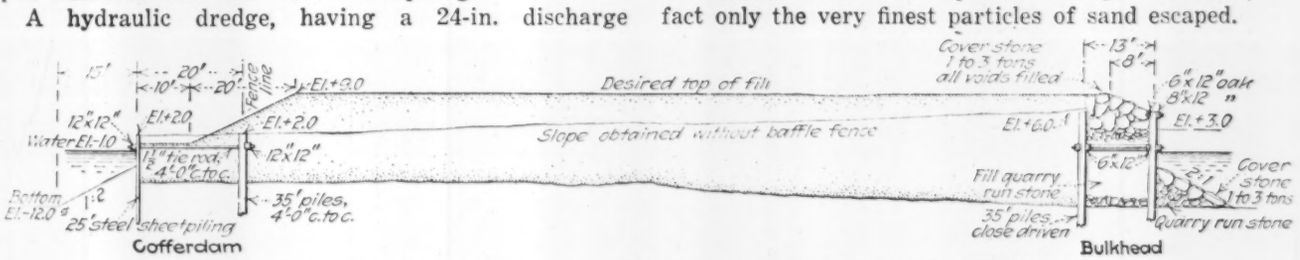


FIG. 2. SECTION OF HYDRAULIC FILL BETWEEN BULKHEAD AND COFFERDAM

No only did the wire cloth fence form an excellent barrier for the floating materials, but it also formed a drain for the fill next to the fence so that very little pressure was exerted upon the fence. In some cases the wire cloth spanned as much as 15 ft. Credit should be given for the construction of the fence to Carl Nelson, field engineer for the Great Lakes Dredge & Dock Co., the contractors for the work.

Population Density as a Basis for Housing Regulations

Intensive Rochester Study Indicates That Improved Transit, Industrial Decentralization, Zoning and Other Current Changes Render Dense Tenement Populations Unnecessary in Most Cities

By Frank B. Cartwright
Assistant Engineer, Bureau of Municipal Research, Rochester, N. Y.

IT IS THE OBJECT of this discussion to demonstrate that the tenement, in its present form as an urban institution, is no longer justifiable from any point of view, and that the housing laws and building codes which regulate tenement construction are without logical bases for their requirements and limitations. The observations which led to these conclusions were made in the course of a study of the Rochester building code, and of zoning procedure, land and improvement assessment and transportation facilities in that city. It is believed that an analysis of the housing conditions in any large city may be made in the manner described and that such an analysis will show almost invariably that the density of population allowed by the building

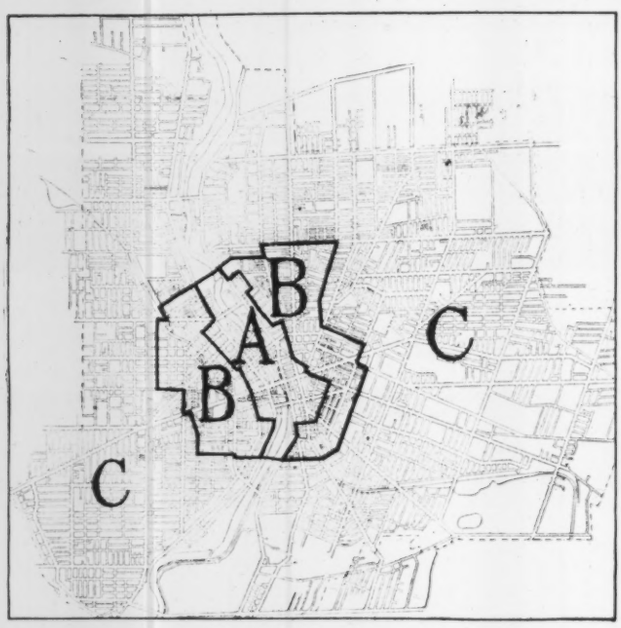


FIG. 1. THREE MAIN USE DISTRICTS, ROCHESTER, N. Y.

code is unjustifiable from the point of view either of the public, the tenement owner, or the tenement dweller.

It is a question whether the dense concentrations of human beings and their works, now characteristic of our cities, will not entirely disappear within a comparatively short period under the influence of recently developed transportation facilities. It certainly is true that many of the generalities which apply to the previous development of cities must be cast aside in predicting future development, because the reasons which underlie these general rules have altered or disappeared. The city stands for co-operation, which involves also association of human beings. Therefore, up until recently, the city was of necessity a close-packed hive of humanity. The telephone and an increase of several hundred per cent in the efficiency of transportation have removed in part the necessity for concentrating large numbers of people upon small areas of land. The results of these changed conditions are just beginning to be important, and one of the first to be expected is the elimination of the tenement as it now exists. Its only reason in the past has been the need of working men and women to be within a short distance of the highly centralized industrial and commercial districts in which they were employed. The area within walking distance of these districts or within the radius of cheap and quick street transit was much restricted by lack of the rapid transit facilities, the comprehensive street-railway systems and automobile transport which we now have. The number of people who were called upon to reside in close proximity to these central areas was unlimited by any restrictions on the height or area of the business structures which were built to house their labors or by any distinctions as to the type of enterprise which could be carried on within those areas, limitations of both of which are characteristic of the building codes and zoning ordinances now in force.

The need to be near the place of employment was capitalized by land owners and disproportionate land values were created, based on the very dense type of development necessary because of the concentration of the working population. The high value of land in turn required that every possible inch of surface be developed to as great a height of structure as was practicable in order that the builders' investment might pay dividends, and the watchful land owner followed, or in some cases anticipated, each new possibility of development with a further increment in the valuation of land. The limit of this progression, both figuratively and actually, was the sky, before building regulation stepped in, and the result was the congestion of population and low standards of housing which we find in the older tenement districts of American cities.

With the coming of better, quicker and cheaper transportation facilities, the need for such concentration in great part disappears. An increasing proportion of the population possesses sufficient income to allow of occupying private homes in the outer areas of land which, by reason of their greater extent in comparison to the demand, are cheaper, and to afford the time and expense involved in the longer journey to and from work. This effect of rapid transit, slow at first, is accelerating rapidly, and lately is much increased by the tendency toward decentralization of industry and by certain other causes to be discussed a little later.

Present Methods of Regulation—The need for tenements, at least partially, has ceased, but their construction continues under control of building regulations, usually known as "tenement house laws." Practically all of these laws now in force are fashioned along the same lines, being adaptations of the tenement house law evolved for the purposes of New York City. Each sets a limit to the height of tenement structures and the percentage of lot area which they may cover under different sets of conditions; prescribes to a certain extent the size and arrangement of courts and yards provided for entry of light and air; and regulates the size and arrangement of rooms and windows. Variations between laws occur rather in the terms of

such restrictions than in the method. Each represents a compromise between the recognized disadvantages of tenement house life and the influence of those who would have tenement building unregulated; in other words, a balance between the interests of the tenant and the builder.

Through such laws an attempt is made to assure the tenement dweller of certain desirable privileges by the withdrawal of which his landlord would profit. The degree to which his general welfare is protected has depended in the case of each tenement house law on the adverse influence of the tenement house builders as a class, on the extent to which tenements were regarded as a necessity, and on the extent to which the courts have been disposed to regard such regulation as coming under the police power.

Determination of Necessary Population Density—To arrive at the facts which would govern population density in the absence of the special influences mentioned above it is necessary to consider the territorial relations which characterize the usual American city.

Lacking the influence of special topographical features, a city will be roughly circular in shape and made up of three concentric areas. There will be a central section, *A*, for business and industry; a belt, *B*, of surrounding heavy residential areas, the outer radius equal roughly to the distance that people will walk to and from work; and a still larger belt, *C*, of territory which can be reached in a reasonable time by surface cars. The two outside areas will usually be cut by several radial thoroughfares along which are business buildings in the heavy residential belt, and business and tenement buildings in the outer belt. Speaking in general, the population of the city lives in the *B* and *C* areas, and works, shops and amuses itself in the *A* area. The boundaries of such districts are often vague; business or industrial foci will exist in the outer areas; and isolated residence districts in the central area, but if balanced against the mass of the city these exceptions will be found to be unimportant in extent.

It has been found that one mile is about the maximum average distance which people will walk to and from work, and five or six miles about the limit for ordinary street railway transportation. The outer radius of the *B* area will therefore be about one mile and that of the *C* belt not over five or six miles from the center of the *A* area. Local conditions may and do distort these boundaries, extending them in one place and withdrawing them in another. Some form of rapid transit, with a consequent unbalancing of the city's growth, usually enters in before the maximum limit of the outer belt is reached. Speaking in general, however, conditions will be about as described.

A portion of the population must, by reason of poverty, or will, by preference, live close to the center area; or within the outer boundary of the *B* area. The rest of the people in the city, able to spare the time or the money, will live outside the *B* area and mostly in one- or two-family dwellings, both of which avoid most of the abuses connected with tenement houses. It appears, then, that the extent of tenement housing necessary depends solely on the necessary population density in the *B* area. The excuse, if any, for multi-family dwellings, or rather for more such, if they are built, will be that the area within the one-mile circle will not otherwise accommodate those who must live there. The density of the population in the crowded *B* area; the height of the tenements there; the narrowness and dampness of their courts; the lack of play area for children, and of privacy for elders; all the abuses which go with tenement life and to which building codes and housing laws attempt to set limits, logically should depend on the extent of the area and the population which must be sheltered. It appears, furthermore, that legislation concerning the height, area, and structural arrangements of tenements, being in effect a compromise between the apparently conflicting interests of different classes, does not go to the root of the matter. The solution of the problem is arithmetical. A division must be performed: — population ÷ acreage = population density. With the quotient in mind, each tenement must be limited to accommodate as many people as the acreage of its lot will warrant and reasonable and compatible restrictions as to height, area, and structural arrangement must be provided. Only thus will housing regulations be evolved which afford a maximum of public protection in the face of the practical demands of the situation.

Having reached this conclusion, it remains to determine for the individual city the dividend and divisor, the prospective tenement population, and the acreage available for its accommodation. It is difficult to make close estimates of these matters, for there are many factors which may influence the flow of population, not all of which can be foreseen. The problem is much simplified in cities which have adopted zoning ordi-

FIGS. 2 AND 3. TENEMENTS SHOWN AT THE LEFT (2) ARE DIRECTLY ACROSS THE CORNER FROM THOSE AT THE RIGHT (3)

The families housed in the tenements, if evenly distributed, would give a development on the land shown in (3) more in accordance with site value.

nances and in which, as a consequence, the boundaries of the respective areas are well defined. It is possible, however, in any case to make such estimates with sufficient accuracy to permit of regulating tenement building so that the cupidity of landlords alone will not determine the type of the city's housing accommodations. It does not appear that the preparation of such an estimate or its support in the courts is more difficult than many of the investigations which have been necessary to the preparation of zoning plans.

To make this discussion apply more generally the following demonstration, which is based on conditions in Rochester, N. Y., is made without reference to the zoning ordinances in force there, though the effect of these is to define a much larger tenement area than the size of the city would seem to justify.

Area of "B" Districts—Rochester's present business and commercial development is mostly comprehended in an area 1½ miles long and ½ mile wide, symmetrically located with respect to the Genesee River and Main St. There are a number of growing industrial centers and many scattered plants outside this area. There also are many dwellings, both tenement and otherwise, within the central area as defined on the accompanying map. All these appear for the prosecution in the case against the tenement, since they tend to reduce the number of people who must be housed within walking distance of the central area, and to make it easier for workmen, without crowding, to be near their work.

In the case of Rochester the one-mile limit for the outer radius of the *B* area results in a belt ¾ mile wide on both sides of the central area, and ⅜ mile wide on both ends. As noted heretofore the *B* belt is cut by a number of thoroughfares only partly usable for residential purposes, and there is also a considerable area at each end of the business district which is not inhabitable on account of the river and industrial developments. After making allowance for these lost areas there still remain the two side belts, which are 1½ miles long and ¾ mile wide, a total area of about 1,200 acres. It is not meant that this area is that required to house the entire working population, but that the areas described are the only ones within which the erection of multi-family dwellings might be justifiable through the need of people to be near their work. Other commercial and industrial foci in the city are small enough or scattered enough to permit of housing their tributary population in normal fashion.

Maximum Population Density

Population in "B" Districts—The following observations, taken together with Rochester's population of approximately 300,000, are helpful in determining the population which the 1,200 acres may reasonably be required to accommodate.

1. With the possible exception of New York, from 50 to 90 per cent of our larger urban populations live in single- or two-family dwellings. Data gathered in the course of a census of refuse collection stops, made in Rochester in 1917, indicate that eight out of ten Rochesterians are thus accommodated.

2. At about the million mark in the history of a city ordinary street-railway transportation becomes inadequate and rapid transit facilities of some kind begin to spread the population more widely and to break up the normal balance between population in *B* and *C* areas. Because of conditions in Rochester, unusually favorable to rapid transit development, it is thought that this influence will be felt before even the 500,000 mark is reached, but here, as elsewhere in this discussion, it is intended to make every necessary assumption well on the safe side.

3. Business and pleasure traffic increases about as the square of the population. For a Rochester of 500,000 people street traffic would therefore be nearly three times as great as at present. It is inconceivable that such an increase could take place without a considerable expansion in the central area and corresponding growth of the *B* areas. In fact, traffic difficulties already have resulted in the initiation of a parallel to the main business street, which will widen considerably the *A* and *B* areas as they stand at present.

Decentralization of Manufacturing Plants

4. There is a steady and increasing movement, both in Rochester and elsewhere, to decentralize manufacturing and to build up industrial centers about the present outskirts of the city. Each move of this kind tends to spread the population more evenly and to reduce the strain upon the housing accommodations in the *B* areas.

5. The average population density of the ten largest cities in the United States is less than 20 persons per gross acre. Rochester, in spite of its comparatively large park and water areas, has better than 18 persons per gross acre. It therefore is not to be expected that an increase in the population will mean a much greater population density or more inhabitants proportionately for the *B* areas.

In view of the foregoing considerations and making every possible allowance for the effects of contrary influences, there seems no reason to expect that Rochester's tenement belts will be called upon at any time to house more than 30 per cent of the population or that the city's total population will exceed the half million mark without either a corresponding increase in the areas devoted to tenement dwellings, a lightening of their load through rapid transit facilities, or both of these influences working together. This means that the 1,200 acres referred to have in prospect at most a demand for housing accommodations for about 150,000 persons. The average proportion of this area devoted to streets and other public uses is slightly more than 25 per cent, leaving at most 900 acres net for housing purposes. The average population density necessary over this area therefore will never rise to more than 166 persons per acre.

Possibilities of Present Building Code—As now written the Rochester Building Code admits of tenement buildings covering 70 per cent of an inner lot, and 90 per cent of a corner lot. They may be built to a height not to exceed 1½ times the width of the widest street on which they face. The court and yard regulations are such as to be compatible with the area provisions; i.e., they do not require a greater area than 10 per cent or 30 per cent of the lots.

The average width of streets in the *B* areas is 60 ft. This means that tenements ordinarily may be built 75 ft., or not more than seven stories, in height.

On account of a requirement that tenements over four stories in height be of "fireproof" construction, present practice does not realize the full possibilities of the code. Following is a tabulation of the pertinent facts concerning a typical group of such buildings erected within the last few years. The cases include two

corner-lot developments, one very deep lot and three ordinary inner lot developments.

POPULATION DENSITY IN TYPICAL TENEMENT BUILDINGS ROCHESTER, N. Y.

Item	No. of Stories	No. of Apartments	Capacity, Persons	Area of Lot, Sq.Ft.	Sq.Ft. of Lots per Family	Population per Acre
1	4	24	113	3,175	132.4	1,552
2	3 and 4	80	376	23,902	299.0	685
3	4	21	98	4,860	231.3	878
4	4	32	150	17,000	532.0	384
5	4	32	150	6,000	187.6	1,088
6	3 and 4	48	225	8,380	175.0	1,170
Totals and Averages	4	237	1,112	63,317	267.0	764

It should be noted that not one of the tenements included in the tabulation is over four stories in height. This means that in no case was the land developed to more than four-sevenths of the density which the code allows. In spite of this, the average population for which accommodations are provided is 764 persons per acre, or over 15 times the density of 50 people per acre usual in the outer portions of the *C* area. If all the 900 acres of the *B* areas were to be developed at this rate, their housing capacity would be 680,000 persons. If the full average development for which the code provides were to take place over this area of 900 acres, 1,200,000 people could be housed.

Tenements Not a Community Asset

Economics of the Situation—That tenements as an institution are not an asset for the community is generally conceded. It appears from the data given that in Rochester, at least, they are not justified by the demands of the situation. It furthermore is true, and can readily be proven, that the present possibilities of extreme development of land are not even to the interests of the property owners in the tenement districts.

At the present time the land within these areas is comparatively undeveloped. There are, as noted, occasional lots rather fully developed, but for each of these there are at present a hundred lots occupied by one- or two-family dwellings of the older types. The land thus occupied, by reason of its location, and the present possibilities of extreme development, has a valuation much out of proportion to its present use, and the owners must be considered as holding it as a speculation more than as a year-to-year dividend-paying investment. If these speculative holdings are eventually to pay even a fair rate of interest on the money invested, there must at some time be a fuller development of the various properties. But as the building code now reads there is no prospect that more than 10 per cent of the land so situated will be developed to a greater extent than at present.

Suppose for a minute that the total population of the *B* areas does ultimately rise to something like 150,000 persons, as the foregoing discussion indicates is possible. Even then, for each of the six lots mentioned above, and for a large number of others similarly developed, there will be eight times as great an area for which only one family per lot can be found. Disregard the questions of health, morals and the amenities for tenement dwellers. Are the property owners themselves going to profit under the present system of regulations?

If each of the present holdings was to be improved as the five lots already mentioned are improved, the population of the *B* areas described would be 680,000. Are any of the hopeful owners of real estate within the tracts devoted to heavy residential use willing to wait to develop their land until Rochester's tenement population amounts to that figure? Some of them must if the building code is not amended. Nor is this the worst of it, for neither of the foregoing suppositions takes account of the 75 per cent greater density of development possible under the provisions of the present building code.

In Rochester, as matters stand at present, property owners as a class suffer rather than profit by the privilege of building large tenement houses. They cannot all build tenements; or they could not fill them if they did. They cannot sell or use their property for business purposes. The use regulations will not allow of it. They cannot sell or use their property for new single and double residences, because people who want or can afford single or double residences will not, to any extent, build or occupy them in tenement districts. The only thing the majority of these owners can do is to hold on and hope for the best. While they do this they pay interest and taxes on an exaggerated and doubtful value which their land has because of the present possibilities of extreme development.

Uniformity of Development Basis of Proper Tenement Regulations—The keynote of tenement regulations should be uniformity of development, not a compromise as to the amount of light, air and space people need for healthful existence. Regulations affecting the height of structures, area and arrangement of courts, yards and shafts, lighting and ventilation of rooms, etc., have been passed, amended, and violated ad infinitum without materially abating the nuisances of tenement house life or protecting the inmates as hoped. The only solution which can be satisfactory and permanent, equitable both to property owners and to the dwellers in tenement districts, is to assume a fair population density, based on investigations such as have been outlined in the foregoing discussion, and to limit the housing accommodations on each lot on the basis of the part which the lot area forms of an acre.

Supplementary Restrictions

Supplementary Restrictions Necessary—It will be argued, very correctly, that the above restriction alone does not guarantee desirable housing developments. Supplementary requirements are necessary, but they are very simple and easily enforced, since the logic of the situation created for the builder precludes any attempts at dark rooms, high structures, narrow courts, small rooms, etc. The following brief list includes all that are believed necessary in the way of supplementary restrictions: (1) No dwellings over three stories in height; (2) no part of a dwelling to be at any point over thirty feet in width, perpendicular to the side walls; (3) no part of a dwelling to face an open area on the same lot, less in width, perpendicular to the face of the building, than 30 per cent of the height of that part; (4) no inclosed part of a dwelling to be closer than forty feet to, or farther than one hundred and twenty-five feet from the center line of a street.

Summary—Recent developments in transportation have removed the necessity for large numbers of people to live within relatively small areas. In consequence, the building of large tenement structures, involving high population densities on certain lots and great unevenness of land development, is an anachronism and should be prevented. The actual demands which will be made on central housing districts may be predicted within reasonable limits and should be made the basis

for a uniform density of housing development to be secured through building regulation. Enforcement of this uniform density, which in Rochester and most other large cities is much less than the rate of development now allowed, will react to the benefit not only of tenement dwellers and of the community at large, but also to that of real estate owners in tenement districts, by establishing a real connection between the market values of their holdings and the possibility of their utilization.

California Motor Carriers Do Large Business—Companies Combine

AN OUTSTANDING feature of recent development in the motor bus business in California is the consolidation of companies made in the interests of more efficient operation. A typical case is the recent formation of an association in Stockton whereby sixty cars, formerly operated by a number of small competing companies and individuals, have been put under a common administration which is expected to make material improvement in service and profits to owners. Combinations have been formed in both south and central parts of the state. Where a number of lines have a common terminal stage depots are becoming popular.

Records of the California Railroad Commission show that 157 freight carriers reported last year total receipts of $2,401,336 and expenses of $2,292,889. A total of 350 passenger carriers, reporting for the same period, showed receipts of $6,856,161 and expenses of $6,028,821. The accompanying table gives tables and averages for freight and passenger companies affiliated with the Motor Carriers' Association, a representative group of bus companies with headquarters in southern California.

With improvement of operating conditions, better roads and more business, the type of passenger cars has been very greatly improved. The accompanying illustrations show a typical passenger car of a few years ago and the modern semi-closed bus of a type being used in many parts of the state since the advent of a system of hard-surfaced roads.

1920 STATISTICS FOR COMPANIES OF THE MOTOR CARRIERS ASSOCIATION

	Length of Routes, Miles	Number of Cars Operated	Total Seats	Car-Miles	Passengers Carried	Passengers Revenue	Operating Expenses	Taxes and Licenses	Liability Insurance	Investment
Total for 18 passenger carrying companies	3,410*	412	5,603	19,587,727*	8,841,408	$3,398,043*	$2,367,014†	$46,615*	$118,353	$1,126,315**
Average per company	200	23	311	1,152,219	491,189	199,885	295,876	2,742	6,575	125,146
			Capacity, Tons			Freight Revenue				
Total for 14 freight carrying companies	517††	83	344	888,085**	.....	674,453	$231,671†	$8,520	$12,791	$256,892†
Average per company	47	6 3	24 5	96,120	.....	48,175	28,939	594	914	32,111

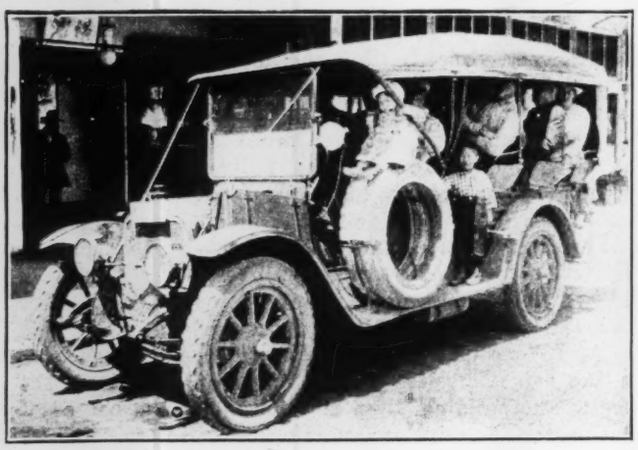
*17 Companies. †8 Companies. **9 Companies. ††11 Companies.

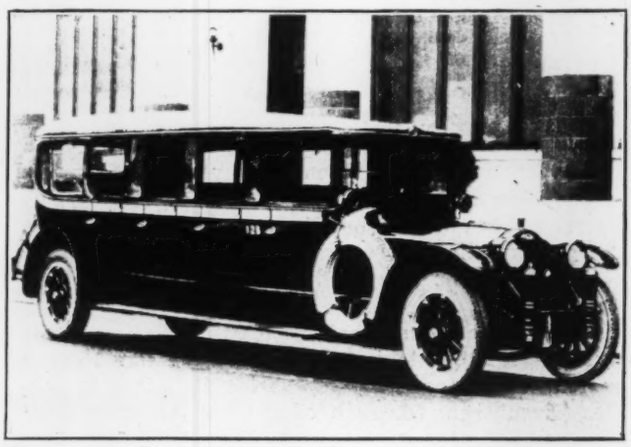
Use of Poison in Maintenance Work on Drainage Canals

By O. C. Kulicka
Drainage Engineer, Greenville, Miss.

THE most important part of the maintenance work on drainage canals, and one of the principal items of expense, is the removal of woody growth, like willows. Cutting affords only temporary relief, as the stumps will sprout again and in a few months conditions will be as bad as before the clearing, if not worse. To prevent stumps from sprouting, experiments with various chemicals were made in the Riverside and Bogue Phalia Drainage Districts of Washington County, Miss. The following method was found most effective:

The trees and bushes within the channels were cut about 6 in. from the surface of the ground, and the stumps poisoned with a preparation made of granulated caustic soda and white arsenic. In a suitable vessel containing 8 gal. of water 10 lb. of caustic soda are poured, and as soon as the water begins to steam from its action upon the soda, 10 lb. of white arsenic are added and dissolved by vigorous stirring with a wooden paddle until the mixture cools. Two gallons of water are then added and the compound is ready for use. Since both the arsenic and the caustic soda are exceedingly poisonous, great care must be taken not to inhale or swallow any of the dust or fumes arising while the preparation is being made. A bottle of vinegar, or some other acid, is kept on hand to neutralize the soda in case of accidents.





OLD AND NEW TYPES OF BUSES—SHOWING INFLUENCE OF IMPROVED STATE HIGHWAY SYSTEM

The best results were obtained by splitting the stumps with an ax, brush hook, or machete, and applying the poison on the frsh cuts with mops made of old sacks tied to sticks about 24 in. long. The organization of the crew varied, depending upon the size of the canal and the density of the growth. In the Bogue Phalia Cut-off, 120 ft. wide at the bottom, with a very dense growth extending for almost its entire width, eight men were used, two men splitting the stumps, two preparing and supplying the poison, and four applying it. In smaller ditches only three or four men were used.

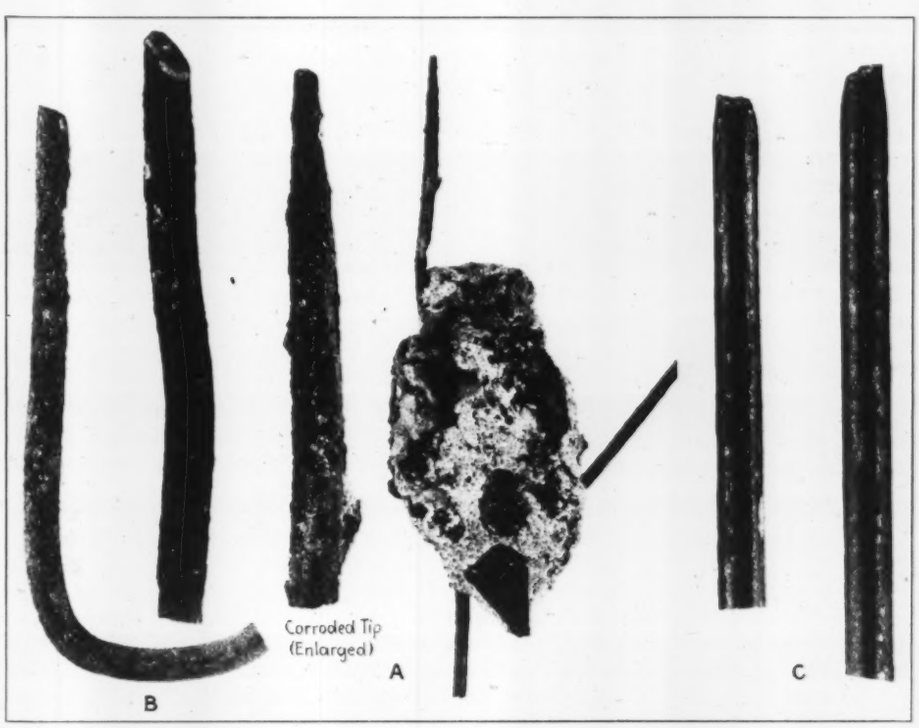
The rate of progress ranged from one-half mile to three miles per day, with an average of about two miles. The average cost per mile was as follows:

Foreman	5 hr.	@	36 c.	$1 80
Laborers	20 hr.	@	15 c.	3 00
Arsenic	25 lb.	@	9½c.	2 38
Caustic soda	25 lb.	@	10c.	2 50
			Total.	$9 68

To eliminate all danger to persons and stock, the property owners and tenants were notified by the foreman superintending the work, notices were published in the local newspapers, and signs were placed conspicuously on the banks of the canals where stumps had been poisoned. Stock should be kept away from such canals for a period of at least ten days.

Corrosion of Reinforcing Wires in Marlborough-Blenheim Failure

Supplementing the facts of the Marlborough-Blenheim kitchen roof-slab failure given by Lewis R. Ferguson on page 271 of last week's issue of *Engineering News-Record*, photographs of some of the reinforcing wires are shown herewith. Along the slab face which Mr. Ferguson concluded was the seat of the failure, reinforcing wires were found corroded as shown by the sample marked "A." The badly corroded end, which has very little sound metal showing on the small fracture face (enlarged view of tip at left) represents an extreme case of rust effect. The two samples "B" show corrosion, but the decided localization of the action is evidenced by the appearance of one of the samples, which shows strong rusting and perfectly clean wire barely an inch apart. The two wires marked "C," at the right, exhibit normal tension fractures. They were also taken from the fractured edges of the slab, and according to Mr. Ferguson are to be taken as indicating that after the failure of part of the reinforcing mesh because of reduction of section, other wires were torn apart by the excess load thrown on them.



WIRES FROM REINFORCING MESH OF COLLAPSED ROOF SLAB, MARLBOROUGH-BLENHEIM KITCHEN

The badly corroded wire shown projecting from a piece of concrete (the tip of this wire is also shown enlarged) was taken from the fallen part of the slab. It was almost rusted through when it broke. At the right are shown, also enlarged, two wires that evidently fractured in tension as shown by the necking and the cup-shaped fracture faces.

Railway Electrification in France

SHORTAGE of coal in France during the World War, with the prospect of continued shortage for many years, led the French government to appoint commissions to consider means of reducing the consumption and also the importation of coal. One evident move in this direction was to introduce electric traction on railways in districts where water power is available. In 1918, therefore, the government appointed a commission on electrification of railways.

As a first consideration it was necessary to decide upon a uniform system, so that the locomotives and rolling stock equipment of any railway could be utilized on other lines if necessary, as in case of war. Committees composed of government officials and the engineers of the several railways studied various installations in the United States, England, Switzerland and Italy. The conclusion arrived at was that 1,500-volt direct-current system should be adopted, the locomotives being equipped with apparatus for taking current from both third-rail and overhead wire conductors. For exceptional conditions, the use of 3,000-volt current may be permitted.

Great economies in coal consumption by steam locomotives had been effected by the French railways prior to 1914, but all these have been lost by the disorganized conditions of fuel supply, labor and railway operation resulting from the war. Oil fuel has been introduced with satisfactory operating results, but France does not produce oil and must import it.

The development of electric traction with hydro-electric power stations is certain, as there is abundant water power available in France. Surveys are being made, a large part of the concessions has been granted, and the work will commence shortly on three railways. Nevertheless, it will be some years, especially with the present delays in construction, before an appreciable saving in coal is reached.

An Investigation into the Use of Bulk Cement

Discussion of the Use of Bulk Cement on Large Concrete Building Jobs' Prepared by the Staff of the Turner Construction Co., New York City

THE generally governing feature for the economical use of bulk cement is a railroad siding conveniently located. Preferably the siding should be within 500 ft. of the concrete plant, and at such an elevation that a practically level runway can be obtained between the car floor and the charging hopper on the mixer. There are times, however, when bulk cement can be received by truck from sidings at a considerable distance, or by sidings close at hand, but at a considerably lower elevation than the charging hopper by the installation of special conveying or elevating equipment.

Frequently a siding either permanent or temporary is to be installed as part of the building contract. When conditions permit this work should be pushed and the layout should be made to facilitate the receiving of bulk cement. For instance, if a saving can be shown to an owner permission may be obtained to put in even a permanent siding at a temporary elevation. Sometimes it is impossible to obtain the use of a siding before the foundation or first floor is completed. In such a case it may prove economical to use bag cement in the early stages of the work and bulk cement for the balance.

Special Plant Possible

It may prove an advantage to spend considerable money for equipment or a special plant layout in order to make the use of cement in bulk possible, for the initial saving in purchase price may be expected to be 5c. per bbl. and there may be additional savings.

The inconvenience caused by cement dust is no greater with bulk cement than with bag cement. In fact the operation of shaking empty bags by hand is disliked more by the average man than the shoveling of bulk cement.

If a great deal of brick or tile work is to be done, it may be advisable to order some bagged cement. This is not essential, however, as bulk cement can be hoisted in carryalls or wheelbarrows on the hod hoist, just as sand is now handled, and dumped in convenient piles on the various floors near the mortar beds.

Table I outlines the principal points to be considered in making an analysis to determine the comparative cost of bagged and bulk cement. The actual figures used will vary with price fluctuations, special local conditions, and labor rates, and are only given for sake of illustrations.

TABLE I.

	Saving per Bbl. Using Bulk	Extra per Bbl. Using Bulk
A—Cost of cement per bbl., f.o.b. cars mill.....	5c.	.....
B—Freight rate (difference is so slight, it may be neglected).		
C—Checking quantity—double weighing of one car in each five. Extra charge by R.R. average $6.00 ÷ 1,150 (230 x 5)	.....	0.5 cts.
D—Storage—It is assumed that storage space at any one time will not have to be provided for more than 10% of the total amount of cement that is to be used on the job. This storage space may be provided in the shape of a raised platform on the floor of the building, or in a wooden shed, and in some cases special mechanical equipment, such as conveyors, may have to be provided. Depending upon these variable conditions, the cost per barrel of cement used on the job will vary from...	.....	1.6c. to 6c.
E—Cost of cleaning, bundling, protecting, and tagging bags for return	2 to 4c.	.....
F—Freight charges and trucking and loading empty bags.....	1.5c. to 3.2c.	.....
G—Loss of bags and money invested	1 to 4c.	.....
	9.5 to 16.2c.	2.1 to 6.5c.

Ordering and Testing

Although the amount of money involved in the re-weighing of cars is small, and not usually a determining factor, the local freight rulings governing in each case should be carefully studied. Charges are generally as follows: If car has not been placed for delivery and written order requesting re-weighing has been received previous to arrival at destination, there will be no charge, provided a variation from shippers weight of 1 per cent or minimum of 500 lb. is found. When the above difference is not found there will be a charge of about $3. When a car has been placed for delivery, or arrived at destination, without re-weighing being ordered, there will be a weighing charge of about $3 and a switching charge of about $7 per car. If a 1 per cent variation or minimum of 500 lb. is disclosed these charges will be refunded.

When placing a contract for bulk cement the purchasing department must arrange to have each car weighed by the shipper both before and after loading. The tare weight stenciled on the side of the car is not always accurate and should not be used. The bill of lading will then show the tare, gross and net weights, and the shipper should also be instructed to show these on his invoice in addition to the number of barrels.

The purchasing department when letting the testing contract should impress on the testing engineer the necessity of having the results of the 24 hr. tests on the job before the cement is unloaded, for when bulk cement is used, it cannot be easily segregated in storage awaiting the result of the test.

Receiving and Checking

The possible sources of loss are from incorrect weights, either tare or gross, by the shipper and loss in transit by leakage from a damaged car. There must also be provided an adjusted check on the volume upon receipt of the car for, due to the constant shaking of the car in transit, and the consequent compacting of the cement, there will be a reduction in bulk ranging around 2 per cent.

The jobs must use care in checking the quantity of bulk cement received, both by weight and by volume, for although the shipper charges in the unit of barrels, the number of barrels is computed by dividing the weight of the cement in any one car by the weight per barrel. It is a general standard to figure the weight of one barrel as 376 lb. or four times the weight per bag of 94 lb. This figure should be confirmed by each shipper for the Canadian standard is 350 lb. per barrel, or 87½ lb. per bag.

To check up on the shipper's weights the job must advise the freight agent at destination to re-weigh about one car out of each five received, and when the car is light to again re-weigh for a check on the tare weight. Job must follow closely to see that light weighing is not missed, and in addition to notifying freight agent should also speak to conductor of switch crew when they take away the light car.

All other cars except those re-weighed must be checked by measuring the volume of the cement in the car, and multiplying by the weight per cubic foot and dividing by weight of cement per barrel. The volume can be easily computed by driving a marked iron rod down through the cement in a number of places to obtain the average depth and by measuring the car dimensions.

When checking up by volume it is necessary to know the exact weight of a cubic foot of the cement in question after reduction in bulk after transit. This unit may be obtained by having the first three cars to come in re-weighed, and then carefully computing the volume and the weight per cubic foot by dividing the total net weight by the volume. After we have made this check on several different jobs, sufficient data may be accumulated to make an assumption of definite weights for certain cement under certain traffic conditions.

Loss of material in transit or damage by water is not very likely, as the cement companies usually line with paper the floor and sides of the cars that are not tight. Should there be evidence, either before or after opening the car, that a quantity of cement has leaked out in transit, or that damage has been caused by water, the freight agent must be notified and affidavits made out as covered in superintendents instructions.

The records of all weights and volume measurements should be kept as in Table II and III. For weight records use a standard size blank book, and for volume records a standard engineer's field book will be found most convenient.

TABLE II. VOLUME RECORDS FOR BULK CEMENT

Shipper _____
Car No. _____
Date _____ 9′ 0″
Width Car Inside _____
Length Car Inside _____
Average Depth _____
Weight per cu.ft. Used _____

Depth Readings

A _____
B _____
C _____
Etc. _____
Average _____

Sketch of Car and Contents

40′ 0″

oA oB oC oD oK oL oM oN
oF oG oH oI oO oP oQ oR

[Use this space for Computations]

Unloading From Cars

The amount to be spent on equipment for handling bulk cement is a question that must be settled on each individual job in the light of the conditions existing. It is generally true, however, that the cement handling equipment so far developed is so expensive, and of such a nature that it is doubtful if it could be economically used in temporary installations for handling comparatively small quantities. Manufacturers are now developing a type of shovel that is intended for unloading cars. There are also certain air conveying systems in use in permanent plants, but the equipment is too costly and complicated to warrant using in temporary installations.

If a condition should be met where the cement storage is close to but at a considerably different elevation than the railroad siding, some form of conveyor might be used. The experience of the cement mills has been that a screw conveyor is the most practical type for approximately horizontal runs. Before installing any type of conveyor some assurance must be had that it will operate successfully.

When the railroad siding is within a reasonable distance of the mixer and is at such an elevation that the car floor is not lower than the top of the charging hopper, unloading by carryalls or trucks or a combination of both, will prove most economical. It is not possible to state a limiting distance when the use of carryalls would become inefficient and the use of trucks more desirable. For if cars are being unloaded, even at a distance of 500 ft. from the mixer, at the same time as concrete was being mixed, it would prove more economical to use carryalls direct from the car to the mixer. At other times when the cement was being placed in storage motor trucks might be used.

When the car platform is at the proper elevation, carryalls can be wheeled into the car. Here they may be filled by two laborers using standard square point shovels. It is false economy to try and use scoops for the average laborer will soon tire with a large shovel and not move as much material in a day as with the standard shovel.

Under other conditions it may only be possible to throw the cement near the car doors into carryalls standing outside and then use wheelbarrows for moving the cement in the ends down to the doorway and there dumping into carryalls.

Where a No. 4 mixer is used and unloading is done with carryalls direct to the mixer it is always advisable to have two cars unloading at the same time. Our experience has shown that one car cannot be unloaded economically and efficiently and at the same time fast enough to keep a No. 4 mixer running at full capacity.

Under normal railroad conditions it should be possible to schedule deliveries so that a large part of the cement received can be wheeled directly from the car to the mixer.

Contrary to what might be expected the storage of bulk cement does not present any unusual difficulties, and in fact the actual cost of placing in storage and removal from storage for use may be considerably less than with bagged cement.

If a storage shed is built, the three governing features are a tight strong floor, a water-tight roof and

TABLE III. WEIGHT RECORDS FOR BULK CEMENT

Shipper	Date	Car No.	Shippers Loaded Weight	Shippers Tare Weight	Shippers Net Weight	Arrival Weight Loaded	Arrival Weight Light	Arrival Weight Net	Variation	Remarks
Penn. Cem. Co.						Indicate whether				Reweighing ordered 3/16
						arrived at by reweighing				Applied for refund
						or by computation				

sidewalls both water-tight and sufficiently strong to withstand the side pressure. The floor should be built of tongue and groove, or shiplap boards, and the floor beams must be sufficiently strong and so placed as to take the load without serious deflection. If lapped flooring is not obtainable the floor may be made both tight and damp proof by covering with old canvas tacked down.

The studs for the sidewalls should be of 2 x 6-in. sound lumber, solidly spiked to the floor beams. When sheeting the side walls use shiplap or tongue and groove boards, always turning the tongue up. The strongest and most satisfactory result will be obtained by sheeting on the inside of the vertical wall studs. Care should always be used to see that the bottom board of the wall sheeting is at least one inch below the floor line so as to make a water-tight joint. The side wall pressure can be taken care of by placing horizontal ties of ½-in. steel rods about 6 ft. above the floor and securing them on the outside with 4 x 4-in. horizontal standards and bolt clamps. This type of construction will be safe for an 8 ft. head of cement.

When possible it is advisable so to locate the storage house in relation to the elevation of the railroad siding, that the cement can be dumped through hatchways in the roof of the shed. These hatchways should be built near the center of the shed, or each section, as the cement when dumped will flow to the corners and almost assume a water level. When it is expected to unload the greater part of the cement by motor truck, it may be possible so to locate the shed that it will be at a considerably lower elevation than the roadway. Under these conditions it may be advisable to build a short timber runway to enable trucks to dump through the hatchway in the roof of the shed. With this arrangement it would be necessary to place a cross partition in the shed so as to facilitate the removal of cement from storage in one section of the house at the same time as cement is being dumped in the other section.

If the cement must be placed in storage at the floor level of the shed it will not be practical to pile to a depth greater than 3 ft. In this case carryalls can be wheeled to the far corners of the space and as the pile builds up run panels should be placed on top of the cement to enable succeeding carryalls to dump at a higher level.

Frequently it will be found possible to receive bulk cement direct from the cars, or to use bag cement, until such time as one or more floors are concreted. A very simple timber platform covered with canvas can then be laid direct on the concrete slab. A toe board about 6 in. high should be built around the edge of the platform to keep the cement from flowing over the edge. The bulk cement can then be placed on this platform either by motor trucks, or carryalls, but should not be piled to a depth that would load the structural concrete beyond its designed carrying capacity.

Measuring the Cement Unit

A satisfactory and efficient method must be used to insure the proper amount of bulk cement going into each batch of concrete, and also to positively count the number of batches in any day's run. With bag cement we have a positive gage of the quantity in each batch, and by counting the empty bags at the end of a run we know the total used.

The simplest gage per batch is to charge the mixer with cement dumped from carryalls or measuring hoppers of a known capacity expressed in bags of cement. As the volume of a bag of cement varies, due to compacting or differences in specific gravity of different cements, the capacity of the measuring device should be checked in each case by filling it with the required number of bags of cement. The cement used for this check must have the same degree of compactness as will be the case during the operation of the plant.

If bagged cement is available, the measuring device can be checked by filling it with the required number of bags of cement. When only bulk cement is obtainable the capacity can be checked by weight. The common factor in the United States is 94 lbs. per bag, but if the cement in question is not of one of the well known brands, or is from a mill in Canada or any other foreign country, a check should be made to determine the number of pounds allowed per bag.

In some cases the cement storage may be at such an elevation, or a small bin may be built over the mixer, so that the bulk cement can be charged by gravity. If so, the measuring gage or hopper must be visible so as to guard against the possibility of the cement arching and not entirely filling the measuring hopper.

Our present method for checking the total amount of bulk cement used per run is by making a mark on a board as each batch is mixed. This is a simple and effective way unless the human element fails to function. A check of the bulk cement on hand at any one time is not any more difficult to obtain than in the case of bag cement. Usually it resolves itself to subtracting the amount of cement used from the amount received. If, however, there is reason to believe the record of the amount used is not accurate or for a check on this figure, it is a simple matter to measure the amount in stock in the same way as cars are measured.

Drought Yields of British Water Supplies

The British Ministry of Health has instructed E. A Fawcett, chief engineer of its engineering department, to collect and tabulate statistics showing the yield of the various sources drawn upon for potable water supply in England and Wales in order to establish records of minimum yields during the present drought. An effort will be made to obtain the average daily yield, the minimum yield in 24 hr. during the year 1920 and the minimum yield for 24 hr. during the present drought. According to the London *Surveyor*: "The present drought is almost unprecedented in its severity and duration and is not likely to be equaled for many years to come. The minimum figures on the present occasion will therefore furnish the only possible basis upon which future supply schemes may be developed." Mr. Fawcett has urged that since the minimum yield of underground water supplies may not occur until weeks or months after the drought is broken observations on such supplies should be maintained for some time to come.

Panama Canal Traffic Low

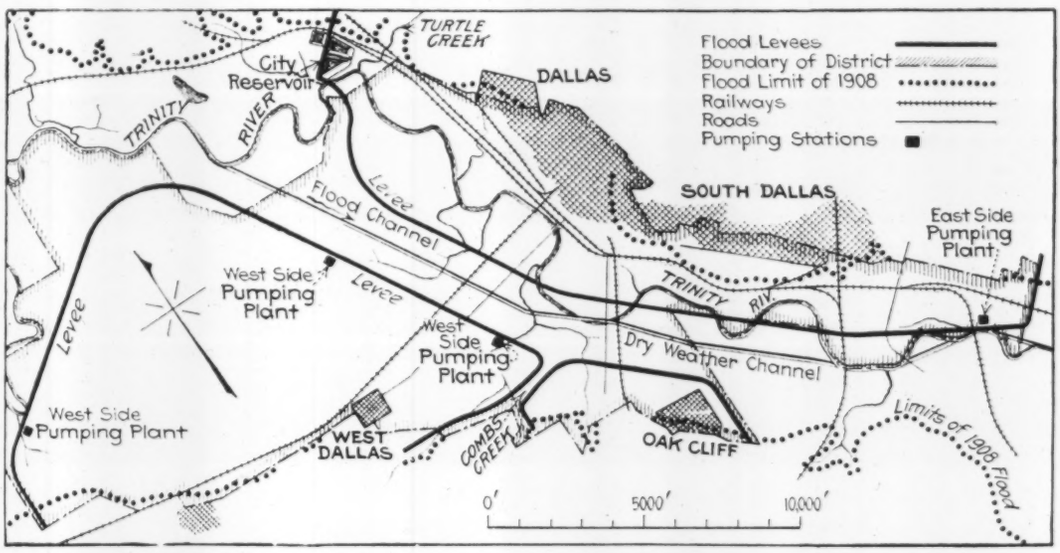
Traffic through the Panama Canal during May was the lowest it has been since June, 1920. Of the commercial ships 118 vessels carrying 334,000 registered net tons passed to the Pacific and 109 vessels carried 423,000 tons to the Atlantic. Total tolls were $792,735 against $974,919 in May of 1920.

Flood Protection Channel Project for Dallas, Tex.

Levees to Control Trinity River, Protect City and Reclaim Low Lands—Pump Drainage in High Water—Flood Records

A 10-MILE leveed channel 2,000 ft. wide through the bottom lands of the Trinity River is the plan proposed for flood protection of the city of Dallas, Tex., and of a large area of low lands now subject to periodical flooding. The main part of the city is on the east side of the river but there are large residential districts on the west side and industrial development is expected within the area which will be protected and which is largely waste land.

To provide for this development the Dallas and Dallas County Levee Improvement District No. 10 was organized in 1920 with an area of 4,300 acres bounded by the high water line of the great flood of 1908. Plans for protection by means of a flood channel were prepared by E. N. Noyes (of Myers & Noyes, Dallas, Tex.), who is chief engineer of the district, providing for levees about 25 ft. high having their tops 5 to 7 ft. above the 1908 flood level. The space between the levees would be cleared of obstruction and in it would be a low-water channel 190 ft. wide and 25 ft. deep, having a fall of 1.66 ft. per mile. Drainage and storm water from the area outside of the levees would be discharged through culverts in the levees during low water periods, the gates being closed and water pumped over the levee during high-water.



RIVER DIVERSION FOR FLOOD RELIEF AT DALLAS, TEX.

The preliminary plans and estimates were submitted by the District to Alvord & Burdick, consulting engineers, Chicago, who approved them, with some minor modifications, after a study of the situation. A brief summary of the main parts of their reports is given below.

At Dallas, the Trinity River, draining about 5,900 sq. miles, occupies normally a V-shaped channel about 25 ft. deep and 100 ft. wide, but overflows several times in a year, the larger floods spreading to a width of from one to three miles and invading the business and manufacturing districts of the city. The frequency of these floods renders the lower bottom lands practically useless.

In the flood of 1908, the greatest on record in 80 years, a height of 52.6 ft. above low-water level was reached, the lower lands being about 20 ft. under water and considerable damage being done in the city, in addition to the interruption of business. The peak flow is estimated at 255,000 sec.ft. or 43 sec.ft. per square mile, which record was approached closely by the floods of 1840 and 1866. In 80 years the flood level of 40 ft. has been reached or exceeded nine times, and for the eighteen years 1903 to 1920 (excluding the 1908 record) the flood levels have ranged from 21 to 40 ft. From the records of other rivers it is considered not improbable that a flood of 33 per cent greater capacity than that of 1908 may occur at some future time. Rainfall at Dallas averages about 33 in. per year, of which only 2.4 in. passes away through the streams owing to high evaporation and retentive subsoil. The 1908 flood followed a series of local storms, the main storm approximating 6.2 in. in 48 hours. With an average flood rate of 47,500 sec.ft. the ratio of the maximum to the average is 5.4, as compared with 4.92 and 3.52 for the Miami and Scioto rivers at Dayton and Columbus respectively in 1913, and with 3.72 for the Kansas River at Lawrence, Kan. Although Texas has only a small annual rainfall its floods are among the greatest in the country. Flood control by detention basins on the Trinity River is practicable to a limited extent, but would involve such great cost that the levee system as proposed is considered the most economical as well as the most effective method for flood relief. Below the city there are extensive levee systems for farm protection, but these would raise the height of minor floods only, as they would be overtopped by floods of over 100,000 sec.ft., corresponding to a height of 41.5 ft. The same is true even if the levees should be raised to the 1908 level, provided that the space within the flood channel is kept clear of trees and brush.

Good material and hard bottom being available for the levees, a top width of 8 ft. with slopes of 1 on 2½ is considered satisfactory. Bank protection would be required only at points where the new channel is close to the levee. As the levee crosses the old river channel at six places and will be about 50 ft. high, specially heavy construction will be required at these points, a 50-ft. berm on the land side being recommended, slightly above the ground level, with a slope of 1 on 20 and then a levee slope of 1 on 4 from the berm to the old river bed. Railways which cross the bottom lands will have to be raised to the level of the top of the levee.

Outlet culverts and pumping plants would be required to deal with the drainage and storm water, there being one such outlet on the east or city side and three on the opposite side. Allowing for storage capacity in the drainage ditches during the peaks of floods, it is considered that the pumping capacity need not exceed 800 sec.ft. against 26 ft. head on the east side and 100, 30 and 7 sec.ft. at the three plants on the west side. Electrically operated pumps are proposed, with five units in the largest station. The total estimated cost is $4,871,500, including $3,210,100 for levees, land and miscellaneous work, $558,700 for five culverts and drainage outlets and $660,000 for four pumping stations.

Reservoirs vs. Additional Pumps for Peak Demands

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Abstract of paper presented at the recent annual meeting of the American Waterworks Association at Cleveland, O.

IN THE planning of a new waterworks project of comparatively large size, or the enlarging of one that is in service, it is necessary to determine how much of the hourly, daily, or monthly peak demands shall be taken by one or more equalizing or distributing reservoirs and how much by pumping engines in addition to those required to supply the average quantity of water consumed over a given period. It is assumed that the reservoir is elevated sufficiently above the highest buildings being supplied and that the distribution mains are of sufficient size to allow the water level in the reservoir to fluctuate over a wide range without appreciably affecting the distribution pressure.

To determine for what variation in demand for water a reservoir should be planned, we have studied the department's pumpage and water consumption records back to the year of 1910, and have assumed that the maximum variation in demand a reservoir will be required to meet, corresponds to the maximum variation found on the maximum day, week, or month of the maximum year during the ten-year period. The study is based on an average yearly water consumption of 100 m.g.d. which is referred to as 100 per cent capacity.

Fig. 1 shows the hourly variation in demand on a maximum demand day, when the total is 150 m.g.d. and the hourly rate ranges from 220 to 60 m.g.d. and the maximum momentary rate of pumpage about 225 m.g.d. If a pumping station furnished water at a uniform rate of 150 m.g.d. a reservoir of 20.6 m.g.d. capacity would take care of all the hourly and momentary fluctuations shown on the curve. If no reservoir were used a pumpage capacity of 225 m.g.d. would be required.

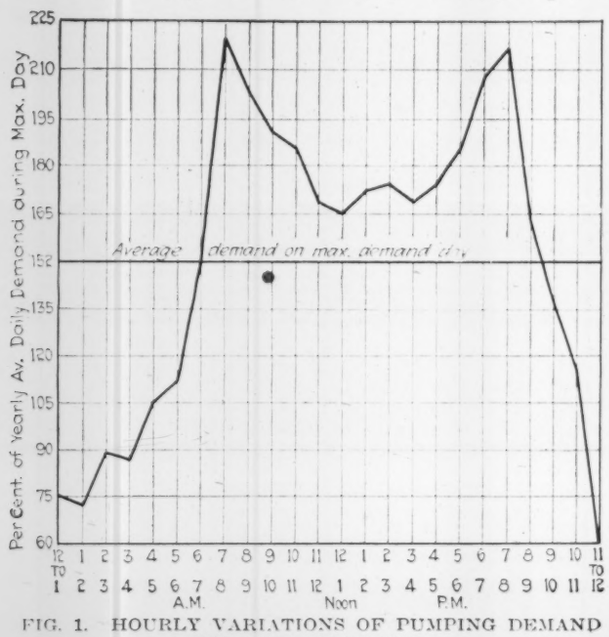


FIG. 1. HOURLY VARIATIONS OF PUMPING DEMAND ON A MAXIMUM DAY

Fig. 2 shows the variation in daily demand of the month having the maximum variation in the maximum year of the ten-year period. The average pumpage for the maximum month would be 126.7 m.g.d. The maximum sustained pumpage above the average monthly pumpage would be for the eight-day period from the 20th to the 27th, inclusive, which would average 135.2 m.g.d. A reservoir large enough to take care of the eight-day sustained demand and the two days of highest pumpage, the 25th and 26th, on which days the demand was 147 and 150 m.g.d., respectively, would more than take care of all other variations in demand during that month, or any other month of the ten-year period.

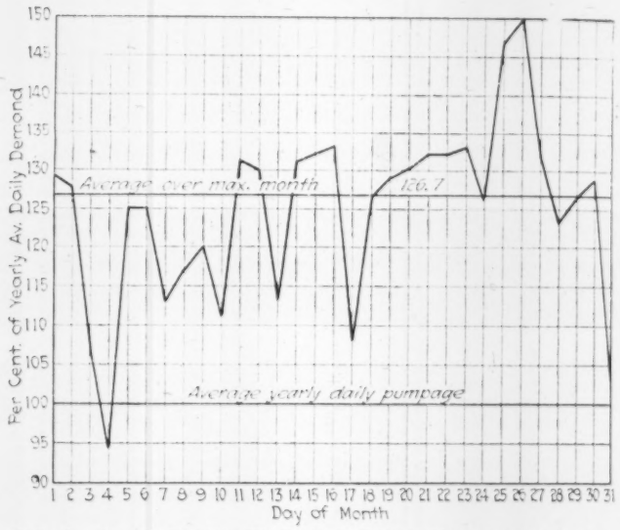


FIG. 2. VARIATIONS IN DAILY PUMPING DEMAND OF MAXIMUM MONTH HAVING MAXIMUM VARIATIONS IN DEMAND IN 10-YEAR PERIOD

Fig. 3 shows the monthly variation in pumpage in the year having the greatest variation over the ten-year period. The average pumpage of the maximum month is 126.7 m.g.d., as was also shown by Fig. 2. If the pumping station should work at a uniform rate of 100 m.g.d. for the entire year, a reservoir having a capacity of 1.8 billion gallons would be required to take care of all variations.

A study of Fig. 1 showed that a 20.6-m.g. reservoir would take care of hourly fluctuations on a maximum day of 150 m.g.d. demand. With a station of larger capacity the size of reservoir decreases. With a pumping station of less capacity than 150 m.g.d. the two days of 147 and 150 m.g.d. pumpage (to simplify, say two days of 150-m.g.d. demand) become the factor which determines the size of the reservoir up to the point where the eight days of 135.2-m.g.d. pumpage require greater reservoir capacity, which corresponds to a station of 130 m.g.d. capacity. The eight-day demand line crosses the line showing the reservoir capacity necessary to take care of the monthly fluctuations over a year's period, at about 124 m.g.d. pumping station capacity. By combining these lines into one curve we can determine from the curve the size of the reservoir required to take care of any demands which will be made upon it over a year's period, with different capacities of pumping stations supplying the average demand.

Having determined from the curve the combination of sizes of pumping station and reservoir required to take care of all fluctuations in demand, we must next find out what the first cost of the various combinations is, in order to determine the most economical combination to construct, in so far as first cost is concerned. The accom-

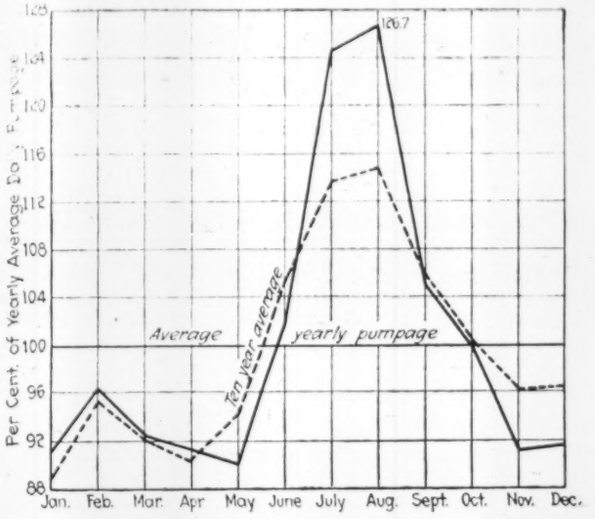


FIG. 3. MAXIMUM MONTHLY PUMPAGE VARIATION IN YEAR OF GREATEST VARIATION IN 10-YEAR PERIOD

panying table shows the approximate costs (pre-war basis) of our various waterworks projects, the average cost per million gallons of capacity for each, and the assumed life of the property upon which we based the annual fixed charges.

COST OF CRIBS, TUNNELS, AQUEDUCTS AND SCREEN WELLS

	Kirtland System	Division System
Type of crib	Permanent steel	Submerged
Diameter of tunnel system, ft	9	10, 7, and 5
Length of each sized tunnel, ft	26,000	16,100 and 9,200
Total cost of intake systems	$1,500,000	$2,530,000
Capacity of tunnel system, m.g.d	175	175
Cost per million gallons per day of capacity	$8,550	$14,450
Average cost of cribs, tunnels, aqueducts and screen wells for Kirtland and Division systems per million gallons of daily capacity	$11,500	

The assumed life of cribs, tunnels, aqueductsand screenwells is 100 years. The cost of land used for water-works purposes nas not been included in this comparison as the yearly apreciation of Cleveland water-works lard more than covers the yearly cost of the bonds which are required for its purchase.

PUMPING STATION COSTS

	Kirtland	Division
Buildings (pumping engine and boiler house)	$600,000	$405,000
Triple expansion pumping engines	786,000	805,000
Boilers, piping and miscellaneous equipment	224,000	190,000
Total pumping station cost	$1,600,000	$1,404,000
Ultimate capacity of pumping stations, m.g.d.	165	165
Cost per million gallon of capacity	$9,700	$8,500
Average cost of both stations per million gallons of capacity	.....	$9,100
Assumed life of complete pumping stations		30 years

FILTRATION PLANT

Cost of Division Avenue filtration plant (rated capacity, 150,000,000 m.g.d.)	$2,250,000
Cost per million gallons of capacity	15,000
Assumed life of filtration plant	50 years
Cost of low lift building, pumps and proportional cost of boilers and miscellaneous equipment	$297,000
Cost per million gallons capacity	1,800
Assumed life of complete low-lift pumping station	30 years

We have assumed that the cost of the distribution system would be the same for direct as for reservoir pumpage, and have not included its cost in any data compiled herein.

RESERVOIR COSTS

	Fairmount	Kinsman	Warrensville
Capcity of reservoirs, gallons	80,500,000	35,600,000	22,300,000
Year completed	1885	1885	1914
Cost of reservoir	$404,400	$159,400	$137,600
Cost per million gallons	5,300	4,475	6,170
Average cost of three reservoirs per million gallons of capacity	.....	$5,315	
Assumed life of reservoirs			100 years

In determining the costs of works at a proper capacity to meet an average yearly demand of 100 m.g.d. with pumping stations of various maximum capacities, a large number of assumptions had to be made and those having the greatest influence on this subject are shown diagrammatically in Fig. 5. In the curve labeled "Pumping Station Buildings, Cribs, Tunnels and Aqueducts" the cost has been increased 80 per cent for double the capacity. This is due to the fact that the unit costs of the tunnel systems and pumping stations would be somewhat less for the larger capacities, and the boiler house building would be relatively smaller due to the fact that the boiler could be run at higher ratings for short periods and the tunnel size could be relatively smaller for peak demands than for steady demands, as the friction loss could be somewhat greater for a peak demand of a given rate than for a steady demand of the same rate. The tunnel capacity does not exceed 150 m.g.d. when used in connection with a filter plant, as the clear water basin is assumed to take care of the hourly fluctuations of filtered water pumpage.

The pumping station boiler and miscellaneous equipment costs curve shows that the costs vary directly with the station capacity up to 150 m.g.d. and that they increase 30 per cent more for a 225 m.g.d. capacity station as compared with the 150-m.g.d. station. The filter plant capacity does not exceed 150 m.g.d. as the clear water basin is assumed to take care of all hourly fluctuations throughout a maximum demand day. No increase has been made in the cost of coal for the plants operating up to 130 per cent capacity, but it has been assumed that the

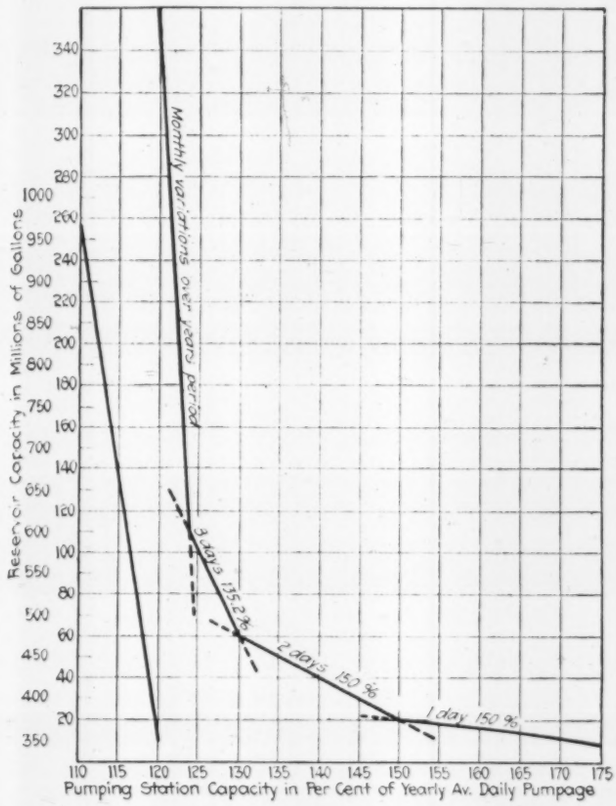

Reservoir Capacity in Millions of Gallons
Monthly variations one year period
3 days 135.2%
2 days 150 %
1 day 150 %
Pumping Station Capacity in Per Cent of Yearly Av. Daily Pumpage

FIG. 4. RESERVOIR CAPACITIES FOR ALL VARIATIONS IN DEMAND IN ONE-YEAR PERIOD FOR VARIOUS PUMP CAPACITIES

coal cost would be gradually increased until it becomes 10 per cent higher for direct pumpage at a 225-m.g.d. peak than for a station which would only have to pump a 130 m.g.d. maximum. With the direct system of pumpage, pumps and boilers run at a lower load factor, as the station must be ready at all times for large fluctuations in demands which would result in a somewhat lower over-all station duty and resulting increase in coal consumption. The pumping station supervision and operation is assumed to increase 60 per cent for an increase in pumping station capacity of 125 per cent. The cost of tunnel operation, which includes cribkeeper's salaries, etc., remains the same irrespective of the size of the tunnel.

Reservoir operation costs consisting principally of keeper's and gardener's salaries vary from $115 p.m.g. for a 10-m.g. reservoir to $15 for a reservoir of 200 m.g. capacity or over.

Filter plant supervision, labor, chemicals and supplies are assumed to be the same over a year's period, whether the plant operates steadily at a 100-m.g. rate or filters up to rates of 150 m.g. per day.

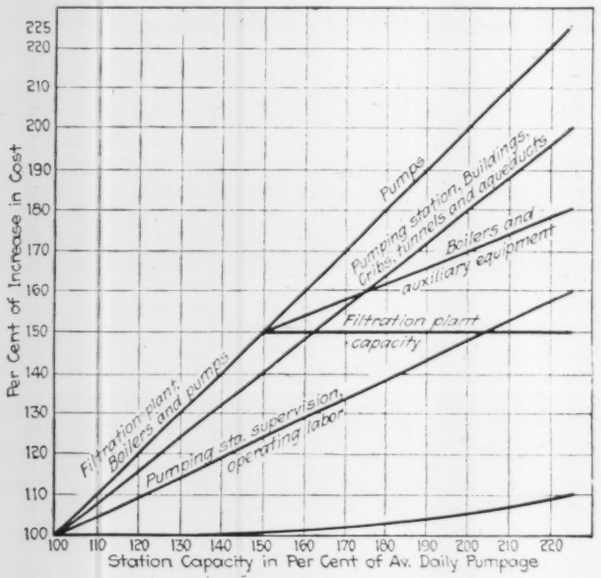

Per Cent of Increase in Cost
Station Capacity in Per Cent of Av. Daily Pumpage
Pumps
Pumping station, Buildings, Cribs, tunnels and aqueducts
Boilers and auxiliary equipment
Filtration plant capacity
Filtration plant, Boilers and pumps
Pumping sta. supervision, operating labor

FIG. 5. GENERAL ASSUMPTIONS OF COST INCREASE FOR VARIOUS SERIES USED IN COMPUTING COSTS FOR INCREASING PUMP CAPACITIES

From Figs. 4 and 5 the tabulated costs of the pumping stations, tunnel systems, etc., we have determined (Fig. 6) the combined first cost of various sizes of tunnels, pumping stations, filter plants and reservoirs required to take care of all variations in demand throughout the year.

The capital charges for conditions *A*, *B*, and *D*, are all approximately a minimum for a 130 m.g.d. pumping station and a 60-m.g. reservoir. For the centrifugal station, filter plant and covered reservoir combination of Curve *D*, the minimum cost would be for a 150-m.g.d. capacity pumping station and a 20.6-m.g. reservoir. These curves also show that it would be just as economical from

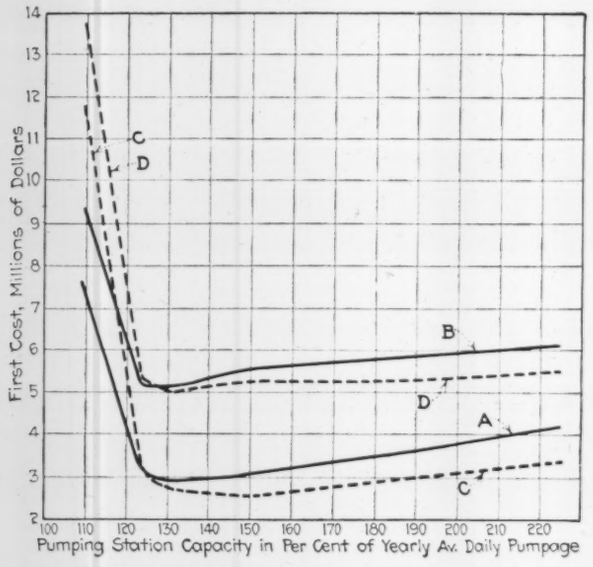


FIG. 6. COMBINED FIRST COST VARIOUS SIZED PLANTS TO TAKE CARE OF ALL VARIATIONS IN PUMPAGE DEMANDS DURING A YEAR

The plants include tunnels, pumping stations, filters and reservoirs.

A: Open reservoir, triple expansion station, based on conditions at Kirtland pumping station from 1904 to date.

B: Same as A, with filters; based on operations at the New Division Ave. pumping stations and filter plant since put in use in 1917.

C: Covered reservoir, centrifugal station; based on Kirtland St. operations, if centrifugal pumps were to be used after Baldwin St. reservoir is built.

D. Covered reservoir, centrifugal pumps and filters; based on conditions at both pumping station, if equipped with centrifugal pumps after Baldwin reservoir completed.

the standpoint of first cost to build either pumping stations of 225 m.g.d. capacity for direct pumpage or open reservoirs of approximately 340 m.g. capacity for conditions *A* and *B*, and closed reservoirs of approximately 240 m.g. capacity for conditions *C* and *D* with the corresponding sizes of pumping stations.

In the construction or reconstruction of a waterworks, the first cost is of relatively less importance than the annual costs made up of operation, maintenance and fixed charges. By the use of Figs. 4 and 5 and the assumptions given below, Curves *E*, *F*, *G*, and *H*, Fig. 7, have been drawn to show the combined annual operation, maintenance and fixed charges for various sizes of tunnels, pumping stations, filtration plants and reservoirs required to take care of all variations in demand over a year's period.

In computing the annual fixed charges the life of the various waterworks properties have been assumed to be a certain number of years, and there has been added to the yearly maintenance cost the annual payment required to retire a serial bond in the amount of the cost of the property, the bond having the same life as the waterworks

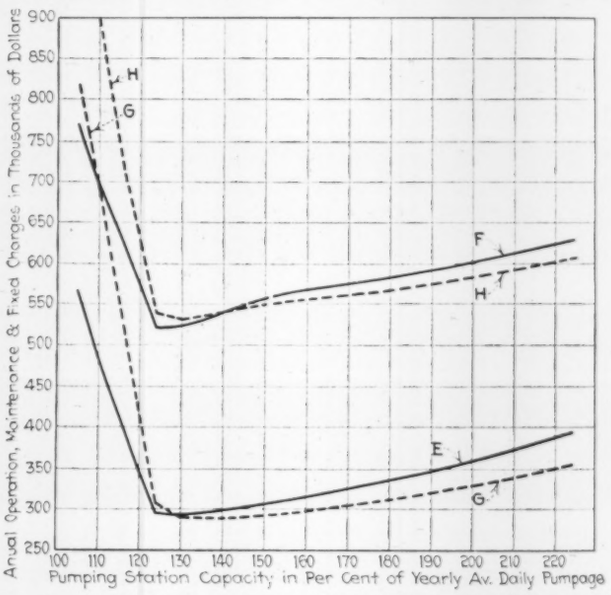


FIG. 7. COMBINED ANNUAL OPERATION, MAINTENANCE AND FIXED CHARGES FOR VARIOUS SIZED WORKS TO TAKE CARE OF ALL VARIATIONS IN DEMAND DURING A YEAR

E: Open reservoir triple expansion engine.
F: Open reservoir triple expansion engine with filters.
G: Covered reservoir, centrifugal station.
H: Covered reservoir with filters.

property being considered. In other words, the money borrowed to pay for the construction of the tunnels, pumping stations, filtration plants and reservoirs, will have been paid back by the time they have become obsolete.

Curves *F* and *G* are a minimum for 130 and 140 m.g.d., respectively, while Curves *F* and *H* reach their minimum points at 124 and 130 m.g.d. The difference between these points in both cases is due to the fact that the cost of operation and maintenance of the triple expansion station, with an open reservoir, is relatively greater than for the centrifugally operated station with a covered reservoir and therefore the pumping capacity of the triple-expansion station would be smaller than the centrifugal for the same annual costs. It will also be observed for Curves *F* and *H*, which include a filtration plant, that the difference in pumping station capacity is 6 m.g.d. whereas for Curves *E* and *G*, which do not include a filtration plant, the difference in pumping station capacity is 10 m.g.d. This is explained by the fact that the annual cost of filtration plant is a relatively large percentage of the entire annual waterworks cost and therefore the difference in annual cost between the triple-expansion open reservoir combination and the centrifugal covered reservoir combination is relatively less.

LETTERS TO THE EDITOR

If you have ideas that would interest engineers and contractors we shall be glad to give them space here. We urge, however, that you be brief so that a wide range of subjects may be covered in the available space.—The Editor.

Design Provisions in Joint Committee Report

Sir—I have read with interest your review of the "Joint Committee's Tentative Concrete Specifications," in the July 14 issue of *Engineering News-Record*. There are, unfortunately, some typographical errors in the report on which this review is based and in at least one instance this has resulted in a misinterpretation of the report. There are a few other places in which the review gives what I believe is a wrong interpretation of the specifications. I wish briefly to call attention to these points, in order to set the matter clearly before the public.

On p. 68 about the middle of the second column is found the sentence: "A footnote gives preference to billet steel pins." Undoubtedly, the word "bars" was intended instead of "pins."

On p. 69 under "Design Provisions," the impression may be taken that for reinforced-concrete beams the only conditions under which as high a shearing stress as 12 per cent of the 28-day strength of the concrete will be permitted, is the case in which longitudinal bars are bent up in a single plane and in which all longitudinal bars are anchored. While it is possible that the summary of working stresses in Article 201 and 202 might lead to this impression, study of Sections 125 and 129 of the specifications shows that the maximum allowable shearing stress of $0.12\,f'_c$ is for the case in which the longitudinal bars are anchored and in which the beams are reinforced with stirrups or bent-up bars or a combination of the two methods.

Although the "Summary of Stresses" is quoted directly from the report, I believe that misunderstanding in connection with the maximum shearing stresses in beams with bars bent up at a single point would be less likely to occur if the summary on shearing stresses in concrete had been made in the original report, as follows:

MAXIMUM SHEARING STRESSES IN CONCRETE

Longitudinal Bars not Anchored.	
(a) Beams without web reinforcement	$0.02f'_c$
(b) Beams with stirrups or bent-up bars or a combination of the two methods	$0.06f'_c$
Longitudinal Bars Anchored.	
(a) Beams without web reinforcement	$0.03f'_c$
(b) Beams with stirrups or bent-up bars or a combination of the two methods	$0.12f'_c$

Under the "Flat Slab Provisions" the term M_o is referred to frequently, but it seems nowhere to be stated that

$$M_o = 0.09\,Wl\left(1 - \frac{2}{3}\frac{c}{l}\right)^2.$$

The sentence indicating the tolerance in the moments might be clearer if it read as follows: "A tolerance of $0.03M_o$ is permitted in the sum of the maximum negative moments in the two column strips and $0.01M_o$ in the sum of the maximum positive moments in the two column strips, as well as a tolerance of $0.01M_o$ in the maximum negative moment and also in the maximum positive moment in the middle strip."

The inference is given that the provisions for the slab thickness are "identical with the provisions of the 1916 J. C. report * * *." The slab thickness provision is identical with the requirements of the 1916 report only for the thickness at the column in the case of the slab which has a dropped panel and provided that the diameter of the column capital is equal to 0.225 times the span, provided also that the dropped panel is 0.4 of the short panel length and that the moment coefficient R, of this formula is equal to 0.54. It should be stated that in the slab formula

t = thickness of slab or of slab plus dropped panel
c = diameter of column capital
l = long span center to center of columns
l_1 = short span center to center of columns
b_1 = width of dropped panel in the direction of the short span or, in the case of slabs without dropped panels, b is $\frac{1}{2}$ the short panel length.

On p. 70, the statement is made that "The general point of inflection is $\frac{3}{16}$ instead of 0.2 in earlier reports." The coefficient $\frac{3}{16}$ is a typographical error which occurred in the Progress Report on which your review was based. The coefficient should be $\frac{3}{15}$. It has apparently escaped your notice, however, that the distance $\frac{3}{15}$ is measured from the center of the span instead of from the support (as in the report of the former committee), so that actually the assumed position of the point of inflection is the same as in the report of the former Joint Committee.

W. A. SLATER,
Secretary, Committee on Design, Joint Committee on Standard Specifications for Concrete and Reinforced Concrete.
Washington, D. C., Aug. 2.

In Defense of Maude and Jerry

Sir—In *Engineering News-Record* of July 21, p. 89, is an editorial on truck mortality. It is no matter of surprise that truck mortality is great. In my experience any gasoline motor is short lived and unreliable. While the blame can justly be placed largely on carelessness and inexperience of the operators, yet it must be admitted that a high degree of skill and careful operation are not generally obtainable. It has been my firm belief for some time that few should purchase either tractor or truck who were not going to operate it personally. This is especially true of the farmer. When one considers the first cost, the cost of upkeep and renewals and the salvage value of the motor and the mule, the latter is without doubt the more economical.

The justification of the motor is in the possibly larger amount of work it can do, not in its greater economy; and now that labor is more plentiful and horse feed is much cheaper, the engineer, contractor and farmer should not forget the possibilities of the mule and horse. In a recent experience of the writer it was observed that in harvesting a field of wheat three good horses and one man were cutting twice as much grain as a tractor and two men. These were being used in the same field under identical conditions. The foreman of the farm expressed the wish that he had had two teams so he could discard the tractor.

The mule has survived, notwithstanding shortage of labor and high cost of feed, an ignorant prejudice. He has had no propaganda in his favor, while our Sunday papers reek with articles on the motor. Our trade journals are congested with advertisements, and paid propagandists roam the country extolling the virtues of the truck, tractor and automobile, while the lowly mule needs none of these things to intrigue the wise purchaser.

Let the prospective purchaser of a truck or tractor visit the bone yards and junk depots—those all too numerous graveyards of truck, tractor and auto—before discarding Maude and Jerry, and let those who have tried machinery observe and try out the possibilities of the mule and I predict that that product of old Missouri, though "without pride of ancestry or hope of prosperity," will be with us for years to come, to our own satisfaction and profit.

Have you ever seen anyone digging a mule out of a mud hole? Or jacking up the leg of a mule on the roadside? Have you ever seen a mule on fire or with his gears stripped? Have you ever seen a collision between two mules? Or ever seen a mule with a broken axle? Have you ever seen a one ton mule team that cost $3,000; or a five ton mule team that cost $5,000; or ever seen either that lasted only a year; or which had an annual depreciation of even 20%?

Have you ever seen a mule team that had to be towed in? And if a mule breaks a hame-string or clevice, does that stop the whole outfit until you can send to town for a 'part" and an "expert" to put it in? Did you ever have to send to Detroit for a mule shoe or a tug, or any other

part, and remain idle until the part arrived? Did you ever think it necessary to build roads costing $30,000 per mile for a mule to travel over?

On the other hand: Did you ever see a truck that knew when it was out of gas or oil? Or that was both an alarm clock and a dinner gong? Did you ever seen one which had sense enough to stop when the plow struck a stump; to refuse to run over a man or to not skid over a steep embankment? Did you ever see a truck that would travel a mountain trail with a pack? Or that you could ride up the middle of a stream while fishing for trout?

Did you ever see a truck that, when lost, would bring you safely home over bad roads, through forest and flood, or that would keep to the road while the driver slept, and at the same time give itself more gas and apply the brakes as circumstances required? Did you ever see a truck that would put its radiator on your shoulder and beg for a chew of tobacco? Did you ever see one that in spite of mud and steep grades and poor drives would ramble right along and deliver the goods? Did you ever see one that grew more valuable during the first four years of service, or one that was tractor, truck, saddle horse and driving animal all in one, and that would repair itself by simply turning it out to pasture?

Long live the mule! May his tribe increase!

Denver, July 28. JOHN E. FIELD,
Consulting Engineer.

Engineering Courses of Professional Grade

Sir—Prof. Burr's address on engineering education gives expression to thoughts that are not uncommon among engineers who concern themselves about the standing and recognition of the profession.

That it is *desirable* that an engineer should be made "a man of cultivation as well as of technical excellence" is an opinion that will be generally subscribed to. It is not only desirable for the personal benefit of the individual, broadening his faculties, widening his scope of vision and increasing the value of his technical training, but for the consequent improvement of the general standard of the profession.

Such cultivation may be acquired by self training, in the course of technical education, or subsequently (fine instances of that kind of successful education are not rare), but the foundation for it will be laid most securely in early life, and in advance of the strictly technical training. It may well be, as Prof. Burr points out, that, "if our secondary schools were administered a little more intelligently," it would be possible to incorporate a course of cultural or liberal-arts work in the education of the young engineer as would add cultivation, without unduly postponing entry into active practice or imposing undue strain in the period of technical study.

To make such preliminary cultural or liberal course a *compulsory* pre-requisite to technical study, cannot, however, be so readily accepted.

It is essential that the engineer should have the sure foundation of thorough knowledge of the scientific principles that govern the work he will engage in; it is not essential though it may be desirable, that he should be even familiar with history and literature in general, or of engineering in particular, or that he should be able to express himself clearly, forcefully and with conviction, or with intelligence and discrimination on public affairs, in general. It may have to be admitted that there always has been, and probably always will be, a relatively large percentage of engineers who are peculiarly fitted to conceive, design and execute the class of work that lies within the province of their calling, and who are, either by mental endowment, limited or specialized, just as peculiarly unadapted to receive any real benefit from a course of cultural or liberal-arts work. To such men, the "closed door" of compulsory preliminary cultural requirement might act as the only obstacle to the full expression of their talents, and, to the profession, might result in non-utilization of the best material.

It is also true, one may suggest, that there always will be a necessary and possibly large percentage of "hewers of wood and drawers of water" within the profession, which class must be relied upon and which ought, for many apparent reasons, to be admitted into the ranks.

The vision of a professional body all of whose members shall, *under compulsion*, be broadly cultivated and thoroughly trained technically, may be a delectable one, but it may be doubted if it is a practicable or obtainable one.

Prof. Burr may be inclined to exaggerate the effect of increased cultivation, by itself, upon the attitude of the public toward the proper recognition of the profession. It may be doubtful if the greater recognition of the legal and medical professions has been due to the broader cultivation of their members, or if the members of these professions would make such contention seriously.

While some of Prof. Burr's comments might be read to imply that he places little reliance on the efforts of organization to secure such recognition, and that apart from his arraignment of S. P. E. E. to properly utilize its opportunities, previous failures of organization cannot be made to justify the conclusion that the desired result cannot be so secured.

The hope of greater public recognition of the engineering profession may lie in the combination of broader cultivation with sounder organization. Concentration of effort should mark the future, as dissipation of energy in a multiplicity of organizations has marred the past.

Los Angeles, Aug. 5. GEORGE G. ANDERSON.

Sir:—Prof. Burr is correct—the engineering profession will never take its rightful place in forums until individuals in the profession, and a large and growing number thereof, are broadly and liberally educated. We need more of language, history, philosophy, ethics and economics and less of the minute technic of manipulation which is common in much of the engineering training now being given, with the result that graduates believe themselves to be full-fledged engineers upon graduation instead of beginners requiring much experience. We need more training for manhood and citizenship with human understanding and less as expert manipulators of processes.

How this much-desired liberal training shall be obtained is not so easily stated or determined. Sometimes it may be in a university, where opportunity is afforded for both kinds and degrees of training in simultaneous work. Sometimes it may be where opportunity, time and personal finances permit, by first securing an academic and collegiate or business training and then by specialization in a recognized institution, devoting its major time to technical work. Or it may well be in many cases where time and money permit of a few years' work, only, beyond the high or preparatory school, that the technical college shall so modify the present rigid curriculum of science and technic to provide less of this and more of the development of manhood.

It must be remembered, however, that there is always opportunity in our varied life for training for all degrees of attainment and in the above remarks the writer would not be interpreted as saying that there is no opportunity for the trade school and the training of those who would become fitted, some even from the graded school work, for the positions of high-grade artisans, mechanics and the rank and file of those who work in the engineering and technical professions under the leadership of the more completely trained man. The responsibility then arises of distinguishing different degrees and breadths of training and this may well be taken care of by classified membership in societies, degrees or registration of engineers.

The paper of Prof. Burr is understood to relate to the training of the higher grades in the profession, to the leaders and directors of enterprises. The catch phrase that leaders are "born but not made" will likely lead us to the erroneous conclusion that training for all shall be alike. There is opportunity for the rank and file, as well as for the captains, and the training may well be differentiated.

It will probably interest the readers to know that at the same meeting at which Prof. Burr presented his paper there was also, among other reports, one by a Committee on Business Training for Engineering Students. This report relates to business training as distinguished from technical training. The reasons for the former are some-

what the same in principle as the arguments for a liberal education. While there are many who still may be displeased with any suggestion to omit less of the technical work and introduce more subjects of general training, it appears that there is a growing feeling, even among the teaching profession, that a great opportunity is being lost in training engineering students for technique rather than for life.

MORRIS KNOWLES.

Pittsburgh, Aug. 5.

[The report that Mr. Knowles refers to endorses the conclusions of the Conference on Business Training for Engineers, held in Washington, June 23, 1919, to the following effect:

1. That there be *required* in all engineering courses 12 to 18 semester hours in the following subjects—general economics, cost accounting, business organization and business law.

2. That there be offered as electives 15 to 30 units in business economics, including labor and employment problems, statistics, corporation management and finance, political science, marketing (including advertising and salesmanship), psychology, scientific management, and transportation.—EDITOR.]

The Providence Club-House

Sir—I would suggest that the Providence Engineering Society furnish as part of its club-house, as described in your issue of August 4, a stock of logarithms in order that the members can borrow ten when they are short, and that the society keep the surplus tens in stock that they may accrue during the process of their weighty deliberations while engaged in the pool, billiard and dining rooms.

Cincinnati, Aug. 10. A CINCINNATI ENGINEER.

Sir—I have read with interest the extremely instructive description by Warren B. Lewis of the proposed club-house for the Providence Engineering Society. It would seem that Providence is the only agency properly equipped to care for institutions of this sort. Present day styles in engineers' club-houses fall far short of the ideal, and any serious, painstaking effort looking toward a solution of existing difficulties is to be commended. The subject is one near my heart, and I know the designer of this act of Providence will welcome criticism and suggestion from a fellow worker in the vineyard.

In the first place a mistake was made in selecting as the site for the building the "center of gravity" of the club membership. It would have been far better to have chosen the center of gaiety or frivolity. However, as it is frequently difficult to distinguish the finer shades of meaning differentiating the terms, the oversight is not fatal. Perhaps the locations might have proved identical.

The method of eliminating overhead is original and effective. There is another *bête noir* of the engineer which might be adequately disposed of in Mr. Lewis' building. That is amortization or obsolescence. I suggest its being stored in the library.

The projection apparatus for lantern slides and movies is not specifically mentioned, but its use is indicated, display apparently to be made on the ceiling. There is a distinct advantage in having the projector handy to the speaker, thus eliminating the operator, but it is suggested that the audience might receive vary impressions from the illustrations, as individuals must of necessity view them from different angles. This difficulty might be obviated by revolving the projector horizontally while the picture is on view.

The cafe is in a position to specialize. Clams will always be easily obtainable, and slightly added expense will provide brooding apparatus on the roof warmed by the protruding boilers, thus making spring chickens and broilers available the year 'round.

Altogether, it's some club-house, I'll tell the world.

W. E. ROLFE,

St. Louis, Aug. 10. Engineers' Club of St. Louis.

A Plea For Easier Building Credit

Sir—Has not the keynote of building depression been struck by E. F. Quirke, in his letter under the caption "Steel Lower," published in *Engineering News-Record*, August 11, p. 250, when he states:

"It is not so much the cost of material that is holding up the jobs as the fact that projects can not be financed at a reasonable rate of interest?"

Are not bankers deterrent factors from their discouragement of prospective builders? It may be they wish to safeguard themselves against drop in value of securities in past building projects with inflated values. Undoubtedly, when steel, which is the leading industry in building, starts to rise in price, building will improve. A banker will not recommend investment in a falling market.

Profiteering has been rampant among labor, material manufacturers and bankers. Labor and materials have been liquidated considerably. When will the banker see the writing on the wall? The banker's slogan lately has been "liquid loans," which result in "get-rich-quick" schemes, that surely can not last long.

A banking system that can only loan money for two or three months (at exorbitant rates), enabling material men and others in similar position to profiteer, but does not permit of long loans at reasonable rates, which are required for building operations and other such works that tend to economic production, must sooner or later bring destruction upon itself.

Labor organizations have learned their lesson. What difference of position can there be between the Federal Reserve and the A. F. of L? Both appear to be country-wide unions, one supplying labor and the other finance.

Boston, August 13. FREDERICK O. LEWIS.

Opportunity for Engineers as Farm Appraisers

Sir—The Farm Loan Act creating the federal land banks and the joint stock land banks for the purpose of extending credit to farmers provides that all loans made by these banks must have the security appraised and recommended by federal appraisers. These appraisers are appointed by the Federal Farm Loan Board at Washington. These men, under the act, are absolute judges as to the quality of the security which is later sold to the public in the form of farm loan bonds. Of course, the several banks as well as the federal board have the privilege to reject any loan they may consider improperly secured. However, they have only the appraisers' report to guide them unless they see fit to make additional investigations.

During normal times the farm loan system will issue from one hundred to two hundred million dollars in farm loan bonds, which are advertised and sold as being made under government supervision and as being absolutely the highest class of investments.

In my opinion the duties and responsibilities of an appraiser are far too important to be left in the hands of a varied collection of appraisers such as the system now has—farmers, engineers, lawyers, real estate men, etc. A great many of these men are without farm loan experience of any kind, nor have they the slightest technical training to qualify them as competent judges of first-class security.

I am of the opinion that only a man with engineering training, a man capable of analyzing a farm or a community as he would analyze an industrial plant or a railroad system is capable of determining the value of a farm as security for investment. He will be required to determine the damage done by periodical local overflows, or the benefit of a drainage system as against the improvement tax levied on the land. In irrigated sections he must be able to study the irrigation system as a whole from an engineering standpoint in order to determine what real benefit any particular tract within the district receives. In hilly sections he should know the meaning of contours and terrace construction. He should also know the value of different classes of highway construction, the chemistry of soils and the preparation of maps. In addition to the engineering qualifications he should also know some-

thing of banking and investments, as well as farm economics and crops. In fact, as I see it, a man with the broadest possible engineering education is required to properly fulfil the duties as appraiser.

I wish to call the attention of young engineers and engineering schools to the need of engineer-appraisers in the farm loan system. I see no reason why schools having a good course in agricultural engineering should not with a little additional training in banking and finances be able to produce men with the necessary fundamentals for beginners as appraisers. I wish also that the need of engineer-appraisers could be impressed upon the Farm Loan Board, which has the matter of appraisers directly in hand.

Certainly there is room for considerable improvement, and with the growing importance of the farm system I believe it wise that engineers give this subject a little of their attention. F. H. SCHREINER, Appraiser.

5th and 6th Federal Land Bank Districts.

Memphis, Tenn., Aug. 6.

A. E. F. Used Similar Built-Up Crossing

Sir—In *Engineering News-Record*, July 28, 1921, p. 162, appears a description of an emergency railroad crossing which would apply almost equally well to the first piece of railroad construction performed by the U. S. Army in France, a matter perhaps of some historical interest.

The writer commanded Company "C" of the 15th Engineers, a detail of which company in August, 1917, at Bassens, France, built a standard-gage 71 deg. crossing from French material, doing the cutting with hacksaws and a very poor oxy-acetylene torch. The crossing was designed by Sergeants Martin and Spears and built under their direction, and was completely equipped with guard rails.

Springfield, Ill., Aug. '. L. D. CORNISH.

More Knowledge Needed of Lime in Concrete

Sir—I notice in the report of the meeting of the American Society for Testing Materials, *Engineering News-Record*, June 30, 1921, a considerable divergency of results obtained by different experimenters on the effect of lime in concrete.

It puts me in mind of my experience some years ago in building a sewage disposal system for one of the institutions under the State Board of Control of the State of Washington. In order to make concrete more dense, 10 per cent of lime was used in the walls of the septic tanks up to water level. I had no accurate testing apparatus with me; but by making bars 2 in. square and 18 in. long, and breaking them by placing them as a beam and gradually loading them, I found the bars with lime to be about 15 per cent weaker than those which had no lime at six weeks time. The bars were poured from concrete as it was placed in the wall, except that it was passed through a screen after mixing to exclude everything over ¾ in. diameter, before placing in the molds. It was spaded into them with a piece of shingle, just as the concrete was spaded into the wall.

On returning to the job three years later, to satisfy my curiosity I obtained a gad and a hammer and tried the concrete, finding that the concrete poured with lime was distinctly harder than that poured without. This applied not merely in one place, but in every place I tried. Strength in concrete may be considered a function of hardness, so I may say that the concrete with 10 per cent lime included was stronger at the end of three years than was that without. The mixes were in every way identical except that a quantity of lime equal to 10 per cent of the cement was added to the batch before mixing.

I also found that in very wet batches the concrete including lime was very much slower in gaining strength relative to the other than in the comparatively dry batches. This effect was so marked as to warrant the belief that it would extend beyond the 28-day period, though my observations were not carried that far.

The logical conclusion from the above is that the effect of lime on concrete is a much more complicated matter than can be unravelled by simple 28-day tests on specimens. Cement and lime are two different substances, which probably do not enter into chemical union in concrete, except to a very limited extent. They have different periods in which they exert their relative effects, and there are a wide variety of conditions which can accentuate or retard the effect of each of them variously. Portland cement is an exceedingly complex and variable substance. Lime with one brand of cement may act very differently from the way it acts with another. We have in the metallurgy of steel a striking illustration of the way in which a very minute change of composition may bring a wide change of characteristics.

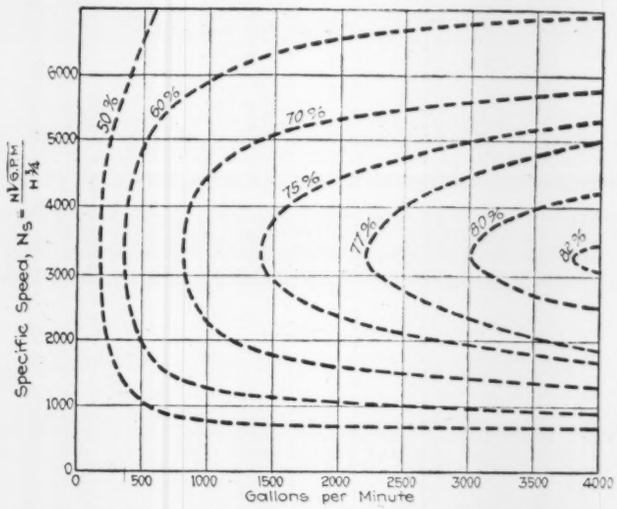
In brief we cannot draw any conclusions on the effect of lime in concrete until we have much more complete information on which to base them. We need long time tests, more data on the composition of the cement and aggregate used, and on the quantity of water.

New York City, July 26. LEO G. HALL.

Determining Efficiency of Centrifugal Pumps

Sir—I was very much interested in the article, "New Method of Determining Efficiency of Centrifugal Pumps," by Prof. Allen F. Sherzer, in *Engineering News-Record* of June 30, 1921, p. 1114. This method will undoubtedly be of much service in estimating efficiencies of pumping installations, particularly in comparing the power requirements of various projects.

I wish to point out an apparent inconsistency, however, in deriving Fig. 3 from Figs. 1 and 2. It will be noted from



EFFICIENCY CONTOURS FOR CENTRIFUGAL PUMPS IN TERMS OF GALLONS PER MINUTE AND SPECIFIC SPEEDS

Fig. 3 that a pump discharging 200 g.p.m. has the same efficiency (50 per cent) for all values of N_s (specific speed) from 600 to 7,000. Similarly, a pump discharging 400 g.p.m. has the same efficiency (61 per cent) for all values of Ns from 1,000 to 6,500. Furthermore, it would appear from Fig. 3, that all pumps with a specific speed of 1,000 having a discharge of 40 g.p.m. to 4,000 g.p.m. have the same efficiency (63 per cent). These conditions might obtain, but from the discussion in the article it does not seem probable. Apparently Fig. 3 is plotted from Fig. 2, assuming the specific speed-efficiency curve to be exactly the same for any pump regardless of the discharge up to the point of maximum efficiency, as given in Fig. 1 for the corresponding discharge. At this point the specific speed-efficiency curve is assumed to follow a horizontal line until it again intersects the curve on the descending side.

I think it would be nearer to the truth to assume that all specific speed-efficiency curves are similar to the one given, having for their maximum efficiency (efficiency at 3,300 specific speed) the efficiency shown in Fig. 1, and having the efficiency at all other specific speeds pro rated. The accompanying chart has been worked out on this basis, and I believe it gives results which are more nearly correct. It will be noticed that the efficiency for specific speeds of 3,300 is the same in every case as that given in Fig. 3 of the article, but allowance is made in this chart

for a reduction in efficiency for all values of specific speed greater than or less than 3,300. A. G. HUSTED,

Assistant Sanitary Engineer, Department of Public Service, Cleveland.

Cleveland, Ohio, July 13.

[Prof. Sherzer replies to Mr. Husted's letter as follows: EDITOR]

Sir—I feel that I am in a great measure to blame for the impression Mr. Husted has in regard to the construction of Fig. 3, and that a further word or two may make the point clear. The illustrative problem was perhaps not wisely selected, being taken at random.

From Fig. 1 of my article it may be seen that for a discharge of 200 g.p.m. an average pump would be likely to have an efficiency of about 52 per cent within a rather wide range of specific speed, and that for all values of the capacity beyond 200 g.p.m. the efficiency will be higher. This enables us to fix the left-hand limit of the equal efficiency rectangles, as shown in Fig. 3.

From Fig. 2 it is seen that from the standpoint of specific speed alone the 70 per cent efficiency line cuts the curve at a specific speed of about 1,250 and again at 6,000. In other words, between the specific speeds of 1,250 and 6,000 the efficiency is likely to be 70 per cent or over. This is the case, however, only if the capacity is favorable. Nevertheless, it serves as a means of locating approximately the lower and upper limits of the equal-efficiency rectangle shown in Fig. 3.

As I stated in the article, it is necessary to interpolate both horizontally and vertically in order to obtain the approximate efficiency desired. This I believe is the cause of Mr. Husted's misunderstanding. Another example will make this point clear. Assume that a pump is to be designed for a discharge of 2,400 g.p.m. and that the operating speed is such that the specific speed is to be 1,250. From Fig. 3 we see that from the standpoint of capacity the efficiency would be likely to be about 78 per cent if the specific speed were favorable. We also see that from Fig. 3 the efficiency for that specific speed is likely to be about 70 per cent in the average case. The actual efficiency will probably be somewhere between these two and may be easily determined by interpolation to be about 74 per cent. From my experience this is about what is usually obtained with such pumps.

I presume Mr. Husted has obtained the same result in some other way, which would probably be just as satisfactory. The point I wish to make clear, and which was apparently overlooked by Mr. Husted, is that it is necessary to interpolate both ways to obtain the desired efficiency. It so happened in the original problem selected that this interpolation was unnecessary, as the point fell in the lower corner of the 65 per cent rectangle, which indicates that from either point of view an efficiency of 65 per cent is probable. ALLEN F. SHERZER.

Ann Arbor, Aug. 1.

Computing Shear in Wooden Beams

Sir—With reference to letter of A. M. Van Auken, of the American Railway Engineering Association, chairman of subcommittee 2 on Wooden Bridges and Trestles, the following expresses briefly my views on longitudinal shear:

In the formulas use v_h for unit longitudinal shear, V for total vertical shear at section under consideration, b and d for width and depth of beam, and x for distance from point of maximum moment to end of beam. The formula in general use for determining longitudinal shear is $v_h = 3V/2bd$. This formula is correct for a single concentrated load, weight of beam not considered, and agrees with what I consider to be a formula of general application, which is $v_h = 3M/2bdx$, where M is the maximum bending moment developed in the beam. The longitudinal shear is equal to the resisting moment of the beam or $3M/2d$, and as the maximum bending moment is taken this will give the maximum longitudinal shear that can be developed in the beam. The unit longitudinal shear I would consider as uniform between point of M and the end of the beam. Deflection has little to do with longitudinal shear and is dependent only on the elasticity of the material.

From the above it will be seen that the loading to produce maximum longitudinal shear is the loading that will produce maximum bending moment. I believe the method of applying the formula $v_h = 3V/2bd$ to determine the longitudinal shear at different sections of the beam is in error.

In a stress diagram the longitudinal shear would be represented by a horizontal line and the vertical shear in a uniformly loaded beam by an inclined line. The intersection of these lines for a reinforced-concrete beam would be at the point where the angle of "diagonal tension" is 45°. The amount of this "diagonal tension" at any section may be represented by the formula $T_d = \sqrt{v_h^2 b^2 + V^2/d^2}$; the unit tension then is $t_d = T_d/b$.

E. E. BELLINGER,
Senior Civil Engineer,
Interstate Commerce Commission.

San Francisco, Aug. 3.

Solid vs. Pneumatic Tires for Trucks

Sir—The discussion of solid vs. pneumatic tires on motor trucks in *Engineering News-Record*, July 28, p. 161, is decidedly misleading because the only comparison drawn is between 12-in. pneumatic and 14-in. solid tires for a 7½-ton truck.

In the first place, the selection of a 7½-ton truck as an example of a truck to be fitted with large pneumatics is unfortunate, since this capacity vehicle constitutes less than 3 per cent of the present production of heavy-duty trucks in the United States. Moreover, in road construction, statistics show that, with respect to the number of trucks in service, the 7½-ton vehicle is a very poor third—5 and 3½-ton trucks being in much greater demand.

In the second place, pneumatic truck tires have not been built above the 8-in. size that have satisfactorily proved their commercial worth. Tires of 9 and 10-in. sizes are still in the development stage while the 12-in. size is a curiosity. It is doubtful if a 7½-ton truck has ever been equipped with 12-in. pneumatic tires for regular use in road construction work.

In the third place, in equipping trucks with pneumatics of sizes up to and including 8-in., actual practice requires that a pneumatic tire one nominal size larger than a solid tire be used to carry the same load. For example, 7-in. single solids or 8-in. pneumatics are standard equipment for the rear wheels of a 2-ton truck. On this basis, a 14-in. solid should be compared with a 16-in. pneumatic, not with a 12-in. pneumatic.

The general question of comparing large solids and large pneumatics in their effect on roads is not one of elementary mathematics, even when size comparisons follow standard practice. There are questions of speed, traction, impact and vehicle upkeep that are not measured by static wheel pressures, but which should be considered, nevertheless, in an impartial comparison. Damage to roads is primarily due to impact and impact is not directly proportional to the contact area. B. J. LEMON,

Technical Service Department,
New York, Aug. 4. United States Tire Co.

Traffic Control in London

The London County Council is to press for legislation for setting up a system of unified control of local passenger transport undertakings in Greater London by a municipal traffic authority to be appointed by the local authorities who are affected. The Minister of Transport has announced the decision of the government not to proceed, for the moment, with a bill for the establishment of a London traffic authority. The establishment of such an authority was recommended by two committees appointed to investigate the London traffic. Various members of Parliament have, however, formed a committee and will shortly make recommendations to the Minister of Transport.

HINTS FOR THE CONTRACTOR

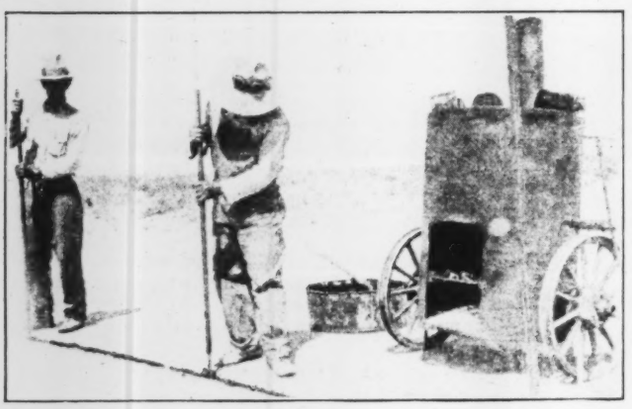
Keeping Concrete Chutes Clear

BY GEORGE GOODWIN
Ottawa, Canada

A simple yet effective method of keeping concrete chutes from jamming is found in the use of an ordinary chain, which is stretched throughout the length of chute. When a jam in the chute threatens, all that is necessary is to pull the chain slightly from the upper end, putting concrete again in motion. The flow of the concrete will then pull the chain back to its normal position.

Oil Heater, Drawn by Hand, Used in Filling Pavement Joints

A HOMEMADE oil heater designed to be operated and moved, together with all supplies and equipment, by a crew of two men, was used on the concrete paving job recently done by the California Highway Commission in Imperial County. Because of the extreme heat to which this pavement is subjected, expansion joints were made 1½ in. wide. This width of joint made it necessary to use some kind of filler that would not flow as readily as does even heavy asphaltic oil; hence, a grade E asphalt was used in which coarse sawdust was mixed when the oil was hot. By using a means of heating the oil which could be moved along the road by hand, a crew of two men could work independently of the main crew.



OIL HEATER AND EXPANSION JOINT AFTER FILLING

The oil heater consisted of an old gasoline drum mounted on a pair of discarded Ford wheels. The opening cut near one end, as shown in the accompanying illustration, gave access to both the ash chamber and fire-box, these being separated by a grate improvised from reinforcing steel bars. A hole was cut in the top of the drum and an iron kettle was fastened there to serve as a vessel in which to heat the oil. The margin around the rim of the kettle served as a place to drain the dipping cans.

A pan about 30 in. in diameter and 10 in. high was used for mixing the sawdust and hot oil, after which the mixture was well compacted in the joints with iron tamping bars.

To move from joint to joint, one of the men took the supply of sawdust and oil as well as tools and wood fuel on a wheelbarrow while the other man moved the heater.

Air Compressor Driven by Engine of Truck on Which It Is Mounted

BY MERRILL BUTLER
Bridge Engineer, Arizona Highway Department

THE accompanying photograph illustrates a portable air compressor outfit mounted on a two-ton truck. It was devised by C. R. Bone, general foreman of the Arizona Highway Department road camp engaged in building a portion of the highway joining the mining towns of Superior and Miami. Difficulty in reaching the shallow rock work with air lines prompted Mr. Bone to build this device.

AIR COMPRESSOR MOUNTED ON TWO-TON TRUCK

An 8 x 8-in. compressor, driven by power from the truck, is set up on the chassis and the storage tank is towed along as a trailer. When in operation the rear wheels are blocked up and the driving belts are put in place. The surfaces of the solid rubber tires act as very good pulley faces. The outfit is capable of supplying air for two large jackhammers. By the simple process of removing the blocking and disconnecting the belts the contrivance is ready to move on to the next location.

It has effected a great saving in cost of piping and trouble of setting up, such as is encountered in rigging a more permanent layout.

The truck engine operates without any excessive heating, using 12 gal. of gasoline and 1 qt. of lubricating oil during an 8-hour shift.

Skid Construction Machinery on Track

IN ASSEMBLING the plant for constructing the Hetch-Hetchy Dam for San Francisco it was occasionally necessary to move motors weighing several hundred pounds from one part of the job to another. Particularly on short hauls, it hardly seemed worth while to raise the motors to flat car level and then lower them to track level again. A means adopted to avoid this consisted of putting a motor on a pair of skids and moving it as a sled to a position on the industrial track with the skids at right angles to the rails, and then dragging it along the rails by means of a chain to the contractor's dinkey. Care was taken to see that the end of the skids which projected over the rails would clear any obstructions that might be met with along the track.

NEWS OF THE WEEK

New York, August 25, 1921

Ask Army Engineer Board To Pass on Bay Crossing

Members of the general committee on the San Francisco bay ridge have signed a report on the Davis-Modjeski plan in which the committee recommends that the "east bay cities join with San Francisco in a petition to the War Department asking for a public hearing and a determination by an engineering board of the United States army as to the general problem of bridging San Francisco bay and what would be the most desirable location within the harbor lines." The report states that under present conditions it is impossible to recommend any definite location but that tentative plans in the Davies-Modjeski report present adequate basis for discussion before an army board.

The report is signed by M. M. O'Shaughnessy, city engineer of San Francisco; Clifton E. Hickok, city manager of Alameda; Burnett Hamilton, city engineer of Alameda; George Mattis, city engineer of Oakland; Lochiel M. King, board of state harbor commissioners; Charles Derleth, Jr., Dean, College of Civil Engineering, University of California; and Marston Campbell.

In addition to this report members of the committee from the east bay cities made public a statement in which they point out that all the proposed plans for bridging the bay have been founded upon insufficient data and are only general in their entire layout and that no plan or scheme should be submitted for general discussion until there has been made a complete survey of the physical conditions to be overcome.

"The traffic to be accommodated," the statement continues, "has never received any consideration other than generalities. There never has been prepared a thorough and complete investigation of terminals and their relation to existing means of distribution of travel in the east bay cities. We feel that all these things are fundamental and we could not as engineers at this time pass upon any project which is not founded upon full information of physical conditions and adequate and complete investigation of terminals and traffic conditions."

Railroad Claims Damages from City for Pittsburgh Slide

A claim for $767,000 has been made by the Pennsylvania R. R. against Pittsburgh for expenses and damages caused by the slide in Jones Hollow below Bigelow Boulevard last November, reported in *Engineering News-Record*, November 25, 1920, p. 1058 and Dec. 2, p. 1076. It is said that there will be further claims by the railroad against the city on this account.

Exhaustive Study

MOTOR-VEHICLE LEGISLATION

Do you know that less than one-half the states are charging the motor-vehicle fees recommended in the proposed uniform motor-vehicle law? This and other outstanding facts on motor-vehicle legislation will be found in a comprehensive article that will appear in *Engineering News-Record*, Sept. 1.

Fire in Woodwork Under Floor Damages Boston Bridge

A fire of unknown origin damaged the Dover Street bridge over Fort Point channel between Boston and South Boston on June 1. Details of the accident have just become available. One span of the bridge was seriously affected, this being an 80-ft. deck plate girder, the middle of three forming the approach to the draw.

Woodwork under the floor of the bridge was involved. The damaged span comprises four main longitudinal girders, transverse floorbeams, and steel stringers framed into these. Nailing strips on top of the stringers carry a 4-in. kyanized spruce deck; a granite block pavement is laid on a waterproofing course on this planking. Sidewalks on either side of the bridge are of asphalt wearing surface on plank on wooden stringers supported by steel cantilever brackets. Under the two middle longitudinal girders of the bridge are located water pipes and electric conduits, below which is a wooden walkway for repair purposes, suspended from the girders. This apparently was untreated wood. The space enclosed by the deep longitudinal girders, the deck planking and the wooden floor below the pipes and conduits formed a long gallery with combustible top and bottom; the fire started in this gallery. The deck planking, the walkway below, and some wooden forms that had been left in place around the electric conduit took fire.

The heat, possibly aided by the effect of water which was played on the bridge by the fire department, buckled and distorted the steel stringers and floor beams and in minor degree the two main girders. Of the latter, the upper flanges were bent and the web buckled, so that the whole span deflected somewhat. The span will have to be rebuilt. The deck planking was found to be charred about ½ to 1-in deep, but the wooden walkway below was badly burned.

The bridge was built in 1894, and the decking is said to be the same that was put in originally.

Senate Passes Amended Townsend Bill

Federal Highway Commission Feature Eliminated—Appropriation Cut to $75,000,000

(*Washington Correspondence*)

The Townsend highway bill passed the Senate Aug. 19 in amended form. The proposal to vest the governmental authority in a Federal highway commission, rather than in a bureau of the Department of Agriculture, was eliminated from the bill and the appropriation was reduced from $100,000,000 to $75,000,000. The reduction was made in the amount to be available during the first six months after the passage of the act. Senator Townsend stated that it would be better to reduce the appropriation during the first six months, than to reduce the amount which would become available during the succeeding period.

The conferees on this legislation, at this writing, fully expect to reach an agreement in time to send the bill to the White House before the Congressional recess.

NO SUPPORT FOR COMMISSION

The most surprising feature of the consideration of the bill was the lack of support in the Senate for the Federal Highway Commission, the feature for which Senator Townsend had worked for several years. In order to retain it in the bill in committee he had made concessions as to the expenditure of federal funds on a secondary system of highways, which, it is believed, he might otherwise not have made. The vote on the amendment eliminating the provision of the bill creating a federal highway commission was 36 to 15. Incidentally the rollcall was an overwhelming vote of confidence for the U. S. Bureau of Public Roads.

The elimination of the commission idea was proposed in an amendment by Senator Curtis, of Kansas. He declared that commissions, as a rule, are not efficient and that it would be particularly unwise to substitute a commission for an agency which is admitted very generally to be doing satisfactory work. Senator Lodge supported the amendment as did Senator Wadsworth. The latter senator announced that he would like to see all public works consolidated in a single department where more businesslike control could be exerted. This statement is of particular significance, coming as it does from the chairman of the committee on military affairs. The most controverted single point in the public works department plan is that it would strip the War Department of certain constructional activities, particularly those pertaining to rivers and harbors.

The Townsend bill, as it was re-

ported to the Senate, was the result of a compromise in the committee. There was every prospect of a deadlock, but as each faction in the committee recognized that there must be an agreement if there is to be any legislation at this session, Senator Townsend finally agreed that the states should designate a system of roads, not to exceed 7 per cent of all the highways of the states. Three-sevenths of the roads included in the 7 per cent were to be designated as interstate roads and the remaining four-sevenths as intercounty roads connecting with the interstate roads. In addition, it was agreed in committee that not less than 60 per cent of the federal-aid funds must be expended on the interstate roads. Senator Townsend pointed out that the compromise is a recognition of the principle, at least, that the federal government shall have something to say about the location of the roads, by confining these roads to a system and stating that the interstate roads must be given attention first.

COMPROMISE REACHED

Senator McKellar, of Tennessee, led the minority of the committee which insisted that the state highway commissions should not be deprived of the right of locating and designating the roads within their states which are to be improved. In order to secure greater power for the state highway commissions, Mr. McKellar and the others of the minority agreed to the provision of the bill creating a federal highway commission. Thus as a result of the compromise, the Townsend bill, as it came onto the floor of the Senate, carried with it no change in the procedure for the approval of highway projects. The provision of the existing law was continued, wherein the states lay out the system subject to the approval of the federal agency.

An amendment was adopted by the Senate, to clarify the spending of the 60 per cent on interstate roads, so that not more than 60 per cent could be expended on such roads, but with the approval of any state highway department, the federal agency may approve the expenditure of more than 60 per cent on the interstate roads. It was revealed in the discussion that the President, in talking with Senator Townsend about the appropriation to be carried by the bill, had said, "Do not make it too large."

Twin Bascule Spans to Be Built Over Mystic River

A double bascule of the double-leaf Strauss type, spanning 118 ft. between trunnions, is to be constructed over the south channel of the Mystic River on the line of Chelsea St., Boston. Two bascule spans will be placed side by side; each is to carry one electric railway track, a 25-ft. roadway and a 5½-ft. sidewalk. With the fixed spans and foundations, the bridge will cost about $800,000. The work is expected to be advertised this fall.

International Road Congress Postponed to 1923

At the meeting of the Permanent Commission of the International Association of Road Congresses in Paris, June 11, it was decided to postpone the Fourth International Road Congress, which had been scheduled to meet in Rome in the spring of 1922. This was done because the Italian government pointed out that the gathering of a great international congress in Italy would, for some time to come, be likely to be exposed to unavoidable inconveniences. Following the receipt of this information the executives of the association made inquiries as to the probability of holding the congress in Spain, and in return, received an invitation from the Spanish government to hold the Fourth Congress in that country in the spring of 1923. The commission unanimously decided to accept.

Five subjects were adopted by the commission for discussion at the 1923 congress: (1) Surfacing of roads with concrete; (2) use of bitumen and asphalt for surfacing (the use of tar and its derivatives is not comprised in this subject); (3) development of motor transport; (4) general traffic regulations; (5) the problem of traffic on congested roads and streets. The fourth topic is to deal with dimensions of vehicles, weights and speeds, width of tires, lighting, brakes, drivers' licenses, etc. The fifth topic is to deal with design and design features that have an influence on traffic and also with traffic regulations.

Apply for Rehearing of Cleveland Union Station Case

The New York Central R.R., the Big Four and the Nickel Plate petitioned the Interstate Commerce Commission Aug. 17, 1921, for a rehearing in the Cleveland terminal case on the ground that the findings are against the weight of evidence. They are not supported by sufficient evidence and are not in accordance with the law. The carriers cite twelve specific instances of error in the opinion and conclude with the statement that the necessity for a union depot, terminal and other facilities in Cleveland is "imminent and vital to the city's future development and progress, as to which there is entire unanimity of sentiment." The application for rehearing is accompanied by a written plea signed by the representatives of civic, labor and other organizations.

City Managers to Meet in Chicago

The City Managers Association will hold its annual meeting in Chicago Nov. 14 to 16 and the National Municipal League will meet in the same place Nov. 16 to 18. During the same week the American Civic Association will hold its annual meeting in Chicago. H. G. Otis, city manager of Clarksburg, W. Va., is secretary of the City Managers Association and H. W. Dodd, 261 Broadway, New York City, is secretary of the National Municipal League.

Indianapolis Appoints City Planning Commission

A city planning commission of nine members for the city of Indianapolis has been appointed. There are five citizen members and four city official members. The latter include the presidents of the board of park commissioners and the board of public works, a member of the city council and Frank S. Lingenfelter, city engineer.

San Francisco Urged to Begin Rincon Hill Regrade

M. M. O'Shaughnessy, city engineer of San Francisco, was recently asked to furnish the board of supervisors a report on the costs of the Rincon Hill regrading project (1) if the entire city were assessed for a portion of the costs, (2) if the project for filling Islais Creek were correlated with it, (3) if part of the entire cost were to be paid out of the tax rate, and (4) whether some of the rock removed from the hill could not be used to advantage in sea-wall construction. A resumé of the proposed regrading project appeared in *Engineering News-Record*, March 24, p. 526.

Mr. O'Shaughnessy reported (1) that for the 140,000 parcels of land involved in the entire city, a 50 per cent addition to the small assessment that would have to be levied against each would be required for bookkeeping and the method in general is not desirable. As to (2) he said the cost of hauling Rincon Hill materials for the Islais Creek fill would be 30 to 40 cents per square yard as against about 15 cents per square yard for pumping mud from the bay and hence the proposed combination is not justified. In regard to the tax rate proposition (3) he said "This policy of financing by committing future administrations to installment obligations without the vote of the people is not in conformity with the spirit of the charter." His report on (4) was to the effect that a soft sandstone formation so generally prevails in the hill that only about 5 per cent could be used in sea-wall construction.

Mr. O'Shaughnessy's plan for financing the work is to levy $1,700,000 of the total $4,000,000 cost on the work against the frontage directly affected by regrading of the hill and the remaining $2,300,000 against the commercial and industrial districts of the city.

In concluding his report Mr. O'Shaughnessy says, "Due entirely to the $4,000,000 Twin Peaks tunnel project, the 90-acre area of land beyond Twin Peaks has increased in assessed value in three years by $700,000 and an actual increment of $2,000,000 has occurred. There is thirty-five times this area beyond the tunnel and still available for use and with development it will have a value of $70,000,000. I believe the Rincon Hill removal will have a similar effect and I believe the work should be undertaken at once and completed inside of two years when values of all property in this vicinity are bound to advance.

California Highway Controversy Debated Before Engineers

Under the auspices of the San Francisco Engineering Council, a meeting was held at the San Francisco Engineers' Club on Aug. 9 at which authorized representatives of the California State Highway Commission and the California State Automobile Association discussed the points at issue in the controversy between these two organizations over the state highway situation. C. D. Marx, chairman of the council, presided. W. C. Howe, consulting engineer and member of the board of engineers, who reported on conditions of the state highway system for the automobile association, spoke for the association. He reviewed in detail the criticisms of past and present policy of the commission and offered suggestions as to changes which were desired. T. E. Stanton, assistant highway engineer, presented the case of the commission setting forth the policies it had followed and the limitations under which it has worked.

After these two presentations had been made a spirited series of questions and discussions ensued, lasting well into the afternoon and in which there was participation by a considerable number of engineers, many of them prominently connected with highway work. It was notable that none of those who criticised the commission made any intimation that there had been any dishonesty or misappropriation of funds.

At the close of the meeting, in summing up the fundamentals underlying various angles of the discussions, Prof. Marx said, "The two factions do not seem to be far apart after all, because the automobile associations appear to be willing to support the highway commission and to aid in raising funds for road work if suitable roads are assured and the highway commission seems to be more than willing to build adequate substantial roads if sufficient funds were made available." No plans were announced for further attempts to get the two sides together and check the present undesirable publicity attending the controversy, but many suggestions to this end were made to Engineering Council officers present.

Zoning Commission Appointed for Baltimore, Md.

In accordance with a recent zoning ordinance passed by the City Council of Baltimore, Md., Mayor Broening has appointed Edward H. Bouton, president of the Roland Park Co., and three others to serve with the following city officials named in the ordinance: Henry G. Perring, chief engineer of Baltimore; Major Joseph W. Shirley, chief engineer, Topographical Survey Commission, and J. F. Crowther, building inspector. The Mayor has stated that it is his intention to ask the Engineers' Club of Baltimore, the local chapter of the American Institute of Architects, and other similar bodies having particular interest in zoning, to appoint members of an advisory zoning commission. Mr. Perring and Major Shirley have already accumulated zoning data which is to be submitted for the use of the new commission.

Build 400-Foot Pile Bridge in Fourteen Days

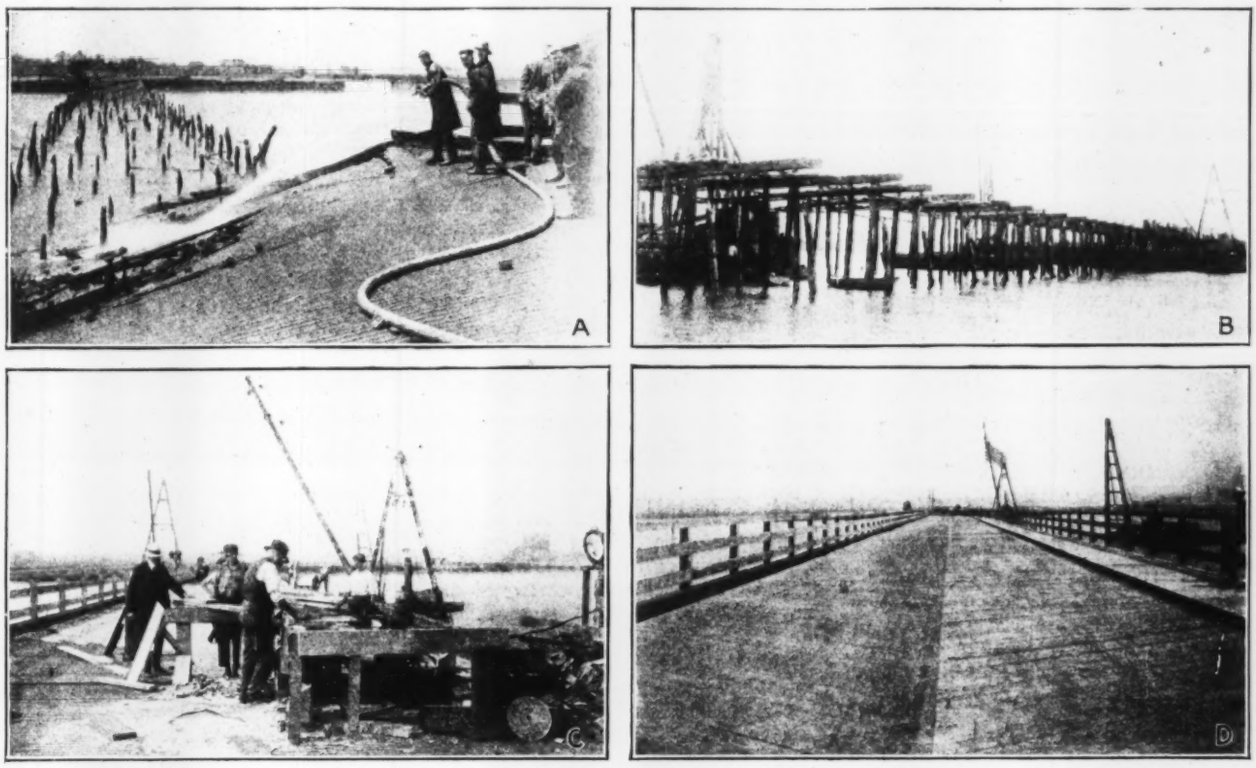
Replaces Structure at Lynn, Mass., Destroyed by Fire—Red Tape Cut

By E. W. Davidson
General Electric Co., Schenectady, N. Y.

City officials and an industrial works pooled interests, cut red tape, and built a 400-ft. bridge 33 ft. wide, at Lynn, Mass., in ten days' actual working time or fourteen days total time within the past month. Here is a brief record of the case:

Fire on June 17 destroyed the Point of Pines bridge connecting Lynn and Revere, a vital traffic artery. On the following day the Metropolitan District Commission stated that a new bridge would cost between $60,000 and $150,000 and no funds were available except a $50,000 state emergency fund. On the 30th, at a hearing held by the commission, the engineer reported that a new bridge would cost $150,000 and travel would be shut off for six months. The General Electric Co., whose River Works is near the bridge, offered to rebuild the bridge in temporary form at cost, in fifteen days' time, on the assurance of H. S. Baldwin, department engineer of the company, and the commission decided to let the company go ahead.

Lynn appropriated $40,000. On July 2 detail plans for the structure were drawn, a labor contract was let to W. S. Rendle Co., of East Boston, for $14,200, and the furnishing of materials and supervision was undertaken by the company itself for $20,000. Work be-



SAUGUS RIVER BRIDGE RECONSTRUCTED IN FOURTEEN DAYS
A—Old bridge after fire, June 17. B—New substructure on July 12. C—Sawing diagonal planking, July 17.
D—Formal opening, July 18.

gan on July 4 cleaning up the wreckage of the old bridge and three days later construction started on the new structure.

Night and day work was necessary to complete the job. Floodlights were put up for night work. On July 12 all the caps but six were in position, and on the 14th it was possible to cross the bridge on loose planking.

Laying the diagonal planking of the 2-in. spruce wearing surface promised to cause delay on account of the sawing necessary, but a motor-driven circular saw table sent out on the job by the company took care of this sawing as fast as the planks could be fed to the saw. The last spike was driven by Mayor W. H. Creamer of Lynn, on July 18, and the bridge was opened to traffic.

The new bridge consists of oak piles, long leaf stringers, caps, decking, and hand railing, and spruce wearing surface; the lumber total amounts to 270,000 b.ft.

ENGINEERING SOCIETIES

Calendar

Annual Meetings

AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS, New York, N. Y.; Semi-Centennial Anniversary, Wilkes-Barre, Pa., September 12-15.

NEW ENGLAND WATER WORKS ASSOCIATION, Boston, Mass.; Annual Convention, Bridgeport, Conn., Sept. 13-16.

AMERICAN SOCIETY FOR MUNICIPAL IMPROVEMENTS, Valparaiso, Ind.; Annual Convention, Baltimore, Md. October 24-28.

The American Society of Agricultural Engineers announces the organization of a reclamation section, composed of members who have a common interest in irrigation, drainage, flood control and land clearing.

The National Drainage Congress meets Sept 22, 23 and 24 in St. Paul, Minn. Some of the papers by engineers scheduled are as follows: Dr. F. H. Newell, on "Colonization"; F. N. DeWolf, on "Legal and Engineering Aspect of Drainage in Illinois," and L. K. Sherman, on "Outlet Drainage and Flood Control Districts." Other subjects of engineering interest are "Practice in Subsidiary Drainage Works Including Filling and Ditch Maintenance"; "Drainage Pumping Plants—Relative Efficiency of Electricity, Steam and Oil" and "Development in Drainage and Excavating Machinery."

Seattle Post, American Military Engineers, held its annual midsummer meeting and outing on August 13, with a visit to Fort Worden and forts guarding the entrance to Puget Sound. When completed in 1911, the works represented the most modern ideas in artillery defense.

The Duluth (Minn.) Engineers' Club, at its annual meeting August 2, elected the following officers: President, W. A. Clark; first vice-president, R. S. Huey; second vice-president, A. M. Frazee; secretary, H. P. Haseneye; treasurer, W. E. Hawley.

PERSONAL NOTES

E. J. BAYER has been appointed engineer maintenance of way of the Evansville, Indianapolis & Terre Haute Ry. (New York Central Lines), with headquarters at Washington, Ind.

D. A. GRANT, formerly assistant engineer in charge of the bituminous construction, Pennsylvania Highway Department, is now general superintendent with Mayer Brothers Construction Co., Oil City, Pa.

GEORGE M. LEHMAN, recently engineer of the Department of Internal Affairs of Pennsylvania, has been appointed chief of the newly formed division of waterways of the bureau of statistics and information of this department. He was chief engineer of the proposed Lake Erie and Ohio River Canal, and still retains his connection with this project in a consulting capacity to the canal board.

PROF. HAROLD J. LOCKWOOD, who has been a member of the faculty of Lafayette College as instructor in physics and electrical engineering; assistant professor in charge of technical physics; in charge of ignition work, vocational section, Lafayette College Motor School, U. S. A.; summer school of surveying, civil engineering department; and the summer school of heat engineering, mechanical engineering department, has been appointed professor of electrical engineering at the Thayer School of Civil Engineering, Dartmouth College, Hanover, N. H.

E. E. ADAMS, assistant to the president, Union Pacific System, has been appointed first vice-president, the Los Angeles & Salt Lake R.R., control of which was recently acquired by the Union Pacific. He will continue as assistant to the president of the Union Pacific in addition to his new duties.

F. G. RANKIN, formerly resident engineer at Hubbard, Tex., with Bryant & Huffman, Austin, Tex., has been appointed assistant resident engineer with this company in Cooke County, Tex.

ALFRED L. KUEHN, vice-president in charge of operation of the American Creosoting Co., Louisville, Ky., has been elected president of the company. He was graduated from the University of Illinois in 1900, and he served for two years as engineer of maintenance of way on the Chicago, Cincinnati & Louisville Ry. and for one year in the same position on the Michigan division of the Big Four Ry. Later he was transferred to the Chicago division with headquarters at Indianapolis, Ind. In 1914 he was appointed general superintendent of the American Creosoting Co., and in 1918 he was promoted to the position of vice-president.

C. A. LATIMER, formerly assistant chief engineer for Francisco & Jacobus, consulting engineers, New York City, and E. G. KAUFMAN have been engaged by the City of Holyoke, Mass., to prepare designs for five new bridges over the canals in that city.

DONALD G. COOMBS has resigned as manager of the production department, C. M. Lovsted & Co., Seattle, Wash., and since August 1 has been connected with the construction department, Shell Co., of California, northern division, with headquarters at Seattle.

J. BLAKE GORDON, senior assistant engineer in the sewer department, District of Columbia, has been appointed sanitary engineer succeeding Asa E. Phillips, resigned. He entered the service of the district in 1900 as assistant to Mr. Phillips and has served for about 14 years. From 1905 to 1910 he was in private engineering practice. During the war he saw service in France as an officer in the Engineer Corps.

W. W. MCCLENDON has been appointed consulting engineer for Navarro County, Tex.

W. S. MAHLIE, of Columbus, Ohio, has been appointed bacteriologist in charge of the filtration plant for the Fort Worth, Tex., water-works.

F. M. CLARK, formerly assistant chief engineer of the Nova Scotia Highways Board, has been appointed construction engineer for the Maine Highway Commission.

ALLAN GARRATT, recently consulting hydraulic engineer to Lockwood, Greene & Co., has opened an office in Boston, Mass., for consultation and advisory work in hydraulic engineering.

W. C. BARBER has resigned as city manager of Dayton Ohio, after serving some six months. He will return to Joliet, Ill., where he was serving as mayor when he accepted the city managership of Dayton.

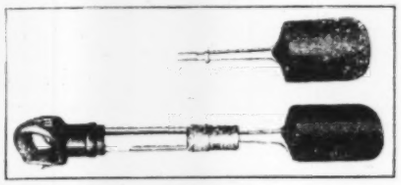
FRED O. EICHELBERGER, director of public service of Dayton, Ohio, for more than a year past, has been appointed city manager, effective Aug. 1, in place of W. C. Barber, resigned. Mr. Eichelberger has been in the service of the city of Dayton for many years. Beginning as rodman in the engineering division, he worked up to the position of engineer in charge of sewers. He was appointed city engineer early in 1915, which office he retained until he became director of public service.

HENRY T. SHELLEY, chief engineer of the Eastern Clay Products Association, Pittsburgh, Pa., has been appointed secretary and manager to succeed the late George H. Tefft. He was formerly assistant engineer of sewer construction with the Bureau of Surveys, Philadelphia, Pa.

Equipment and Materials

Pneumatic Hammer Scoop

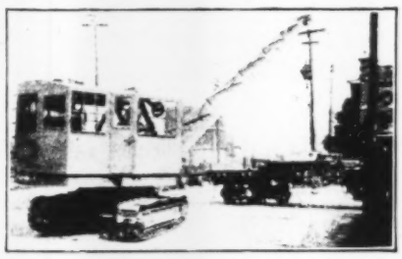
To cut down the cost of loosening stiff clay, hard pan and fine gravel in such excavations where steam shovels and trenching machines cannot be used, the Ingersoll-Rand Company, of New York, is putting on the market the "Little David" hammer and scoop. The hammer is of the long-stroke type, fitted with a special handle. The scoop is held in place by a safety retainer.



In a sewer tunnel job now under way in Detroit, where the bore is about 9 ft. 6 in. diameter, the contractor, using these tools, is averaging 17 lineal feet of sewer per day of 8 hours with four miners. This gives about 11 cu.yd. per man per day. The material is a medium-hard blue clay, which is fairly stiff, no bracing or timbering being needed to hold the roof of the tunnel.

General Purpose Crawling Tractor Cranes

To meet the demand for a full revolving tractor crane which can be operated independently of rails, the Industrial Works, Bay City, Mich., has developed its Type BC and Type BT "Industrial" crawling tractor crane. The former has a capacity of 20,000 lb. at 12-ft. radius and is equipped with continuous crawling tractor belt, while the latter has a capacity of 18,000 lb. at 10- ft. radius



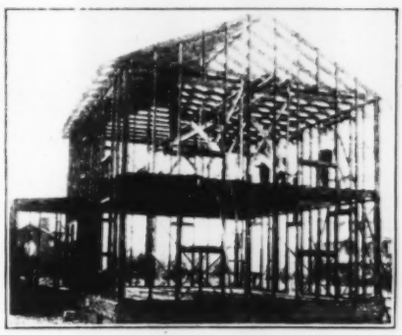
and is equipped with four broad-gage tractor wheels. Both are equipped with 30 ft. booms. The drive is by internal combustion engine.

Special attention has been given to the propelling and steering mechanism and control. The operator can propel and steer the crane independently of all other motions. Either tractor belt can be readily disconnected from the motor while the other belt continues traveling at the normal rate of speed. The disconnected tractor belt can be held stationary by applying the brake, can be allowed to coast with the brake and clutch both disengaged, or the clutch can be allowed to slip, thus allowing the operator to turn as sharp or as wide a corner as he may select. All the clutches, brakes and lever mechanisms for steering are located in the revolving upper works where they are much more accessible than when located on the car body.

Metal Lumber for Home Building

Metal lumber as a material for home building is demonstrated in a two-story residence just erected at Canton, Ohio, by the Berger Manufacuring Co. Taking this house as a beginning the company expects to develop designs for a series of homes, of varying types, dimensions, and costs to meet the tastes and purses of different home builders. For each standard house every metal joist, stud and channel will be supplied of an exact size, so that all parts will fit quickly and easily.

The framing of the outer walls is of 4 in. channel shapes, with the flanges punched with prongs for the attachment of metal lath, which will hold the plastering for the inside of the house



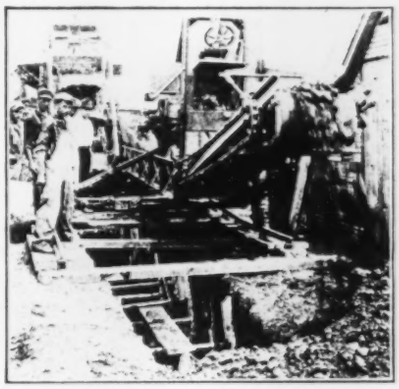
and the stucco for the outside. Partitions are erected of 2 or 4-in. studs on both sides of which metal lath is applied. The floors are built of metal joists, placed 2 ft. apart. To these joists nailing strips are attached so that either wood or composition floors may be installed. Metal-lumber rafters support the roof, to which nailing strips are attached so that any form of roofing may be used. Wood grounds are applied for the installation of windows, door frames, baseboard, picture molding, etc. In the finished house no metal can be seen, inside or outside.

Backfilling Conveyor for Use in Narrow Alleys

Due to limited width it is difficult to operate a trenching machine satisfactorily in a 16-ft. alley without congesting it badly. The earth is piled on one side only, the other being used for stringing out the pipe. For that reason there is very considerable advantage in operating a continuous backfiller with the trenching machine.

To meet this situation the Austin Machinery Corporation, of Chicago, has designed a backfiller conveyor, which, attached to a trenching machine, can work in an alley only 10 ft. 6 in. wide.

A short conveyor takes the excavated material from the standard cross conveyor belt of the trenching machine and delivers it to the main belt, which, driven by a gasoline engine, and therefore independent of the power of the trenching machine, carries the dirt back and into the trench. The device moves on short, light rail sections and is attached to the trenching machine for



traction purposes. The rear end is raised and lowered with a winch; when used in the open it can be used for loading wagons. The back filler is built in sections of 4 ft. 6 in., so that any reasonable length can be used, the conveyor belt being lengthened or shortened.

Out-of-the-Ordinary Trade Publications

The sort of information that the designer and draftsmen want to have handy is found in a pamphlet of twenty sheets put out by the FEDERAL CEMENT TILE COMPANY, of Chicago. It shows the application of interlocking, channel and flat tile to different types of roofs. Details as to gutters, ridges, valleys and collars are given and also data for figuring the amount of tile needed for different widths of buildings and with different roof pitches. Included also are sheets showing details of application of the company's cast concrete sills and wall coping.

A second edition of the National Steel Lumber Handbook is being issued as a 183-page 4 x 6¾-in. cloth-bound manual by the NATIONAL PRESSED STEEL COMPANY, Massillon, Ohio. It has been prepared by the Steel Lumber Division of the company, under the direction of H. M. Naugle and Stanley Macomber. It follows the lines of the first edition and contains the sort of data the designers of ordinary steel work are accustomed to find in the various well-known structural-steel handbooks. Since the first edition was published there have been a number of improvements in the product and some changes in the design of National sections. The new edition covers these developments and amplifies in many respects the contents of the first edition. In addition to the information essential in such a handbook—regarding the properties of the sections, details of connections, etc.—there is considerable auxiliary material in the way of comparisons of cost of designs using steel lumber with other well-known types of construction, data on footing designs, loads permitted by building ordinances, etc.

Business Side of Construction

Facts and Events that Affect Cost and Volume

July Cement Production Exceeds That of June

According to an estimate made by the United States Geological Survey, the production of portland cement in the United States in July was greater than the figure attained in June by 272,000 bbl. The total production for July was 9,568,000 bbl., as compared to the 9,296,000 in June. The report also shows that more cement was shipped than was produced. The investigation was made by the Geological Survey under the direction of Ernest F. Burchard.

The production for the first seven months of 1921 was more than 97 per cent of the quantity manufactured in the corresponding months of 1920 and more than 52 per cent of the total production of 1920. Shipments were more than 96 per cent of those for the corresponding period of 1920 and more than 52 per cent of those for the whole year 1920.

The production of clinker (unground cement) during the seven months amounted to more than 53,000,000 bbl. and the July production exceeded 9,000,000 bbl. July stocks of clinker are reported as more than 4,300,000 bbl.

Southern Pine in Better Condition Now Than in 1920

According to the weekly reports issued on production, orders received and shipments of southern pine by the Southern Pine Association, the condition of the southern pine mills is much better at the present time than at the corresponding period of 1920. For the week ended Aug. 5, the average production for the preceding six weeks showed an increase of 6 per cent over the production of the corresponding period of 1920. For the same six-weeks period, the shipments of 1921 were 43 per cent in excess of the shipments for 1920 and the orders received 8 per cent over the orders received in 1920. For the past few months the production of southern pine has been hovering between 75 and 80 per cent of normal.

West Coast Lumber Production

For the week ended August 13, 107 mills reported to the West Coast Lumbermen's Association a production of 55,908,400 ft. b.m., which is 28 per cent below normal production. New business totaled 58,404,876 ft. b.m., and shipments 61,827,379 ft. b.m In the cargo trade, domestic orders totaled 5,542,796 ft. b.m., and export trade 7,560,133 ft. b.m. Coastwise and intercoastal shipments totaled in excess of 14,000,000 ft. b. m. and export shipments in excess of 5,000,000 ft. b. m.

Unemployment Put at 5,735,000

Pursuant to a resolution passed in the United States Senate on August 5, the Secretary of Labor has, through the Bureau of Labor Statistics, compiled an estimate of the unemployment in the several states. The number of unemployed is put at 5,735,000 in the report issued Aug. 16, the figures relating to the differences in the number of employees carried on payrolls in July, 1921, as compared with the peak of employment in 1920. Figures of the unemployed by industries are:

Manufacturing and mechanical industries (including building trades) 3,900,000; mining, 250,000; transportation, 800,000; trade and clerical workers, 450,000; and domestic and personal service, 335,000. No estimate could be given as to the number of ex-service men unemployed as reports covering payroll data do not segregate them. The same applies to women workers.

The Secretary of Labor in transmitting his report to Congress, made the following statement:

"In consideration of these figures certain conditions must be kept in mind: First, they refer to the change in number of persons employed between the peak of operations in 1920 and the present time, ignoring whatever unemployment there may have been in the spring of 1920; second, that the employment was far above normal in the spring of 1920. Workers' wives, daughters and boys who were not accustomed to work for wages took up gainful work through economic necessity or because of the tempting wages offered. Therefore, the present recession in employment may not be entirely unemployment for regular workers, but a return of many persons from gainful work back to non-gainful home work or schools."

Paper Mill Wages Cut 15 Per Cent

Wage reductions averaging about 15 per cent for all classes of workers have been fixed by a board of arbitration appointed in July to adjust differences between eleven employers and approximately 12,000 employees of paper mills in the United States who went out on strike last May. The strike was called as a protest against the acceptance of a 30 per cent decrease in wages. In general, the new rates represent a 10 per cent reduction for skilled workers and 25 per cent reduction for unskilled workers. The new rates became effective Aug. 22, and will be in effect until May 1, 1922 unless the board should decide to make a change after the end of this year.

There will be no protesting the new rates by the employees as they agreed to accept the judgment of the arbitration board. The arbitration agreement was signed on June 29 last.

Wage Reductions Approach Deflated Living Cost

Chicago Engineers Find Total Cut of 15.9 Per Cent Among 4,540,00 Workers

Average wage reductions of approximately 15.9 per cent since the first of this year for over 4,540,000 workers in industrial concerns in twenty key industries throughout the United States are shown in an analysis of industrial wage tendencies made by the J. L. Jacobs Co., engineers and statisticians of Chicago. The survey made by this agency includes a digest of reports from official documents and reliable periodicals, covering 693 establishments or industrial groups which are typical of the industrial and utility activities of the country and which include every industry of any consequence in the United States.

Wage Reduction Analysis

The summary analysis from the 693 individual and group establishments reporting show that approximately 43 per cent of these industries reduced wages 20 per cent or over; that 19.9 per cent of the total reduced wages between 15 per cent and 19 per cent; that 30.4 per cent of the total concerns reporting reduced wages between 10 per cent and 14 per cent; and that about 6.5 per cent of the total concerns reporting reduced wages less than 10 per cent. Wage reductions in the iron and steel industry amount to 20.7 per cent and in the building trades (in cities) 18.1 per cent.

This average wage reduction of 15.9 per cent for industrial workers throughout the country is still below the average reduction in the cost of living as reported by the U. S. Department of Labor, the total reduction in the cost of living from the peak period in June, 1920, to June, 1921, being 16⅔ per cent.

The instances cited do not cover wage reductions made prior to the beginning of the year, nor proposed reductions which have not been made effective. While the reports from the 693 establishments do not purport to cover all wage reductions, the wide range of industries and the large number of instances covered, show the average reductions throughout the industrial field and the relationship of such reductions with the downward industrial and economic trend which began in July, 1920.

The wage reductions considered in the analysis are actual reductions in salaries and wages. In addition, there have been some reductions through elimination of bonuses and of punitive overtime rates, or through the increase in number of working hours, either without changing the compensation, or along with the reduction of wages.

The outstanding reductions that have been made in the last sixty days are among the public utilities, the building trades and the steel industries.

Clay Products in 1920

The value of clay products marketed in the United States in 1920, as estimated by Jefferson Middleton, of the United States Geological Survey, was $364,220,000, by far the highest value ever recorded. This amount represents an increase of $103,430,000, as compared with 1919; of about $143,000,000 as compared with 1918, and nearly $200,000,000 as compared with 1910. The greater part of this increase is due to the increased cost of production which reached its peak in 1920. However, the quantities of many clay products were greater in 1920 than in 1919.

Common brick was the leading product, the output in 1920 being 4,709,000,000 bricks, an increase of 156,333,000 over the 1919 production. Notwithstanding this gain, the output of 1920 was the smallest recorded, except in 1919 and 1918, and was less than one-half as large as the maximum production which was registered in 1906. The value of this product was $81,330,000, the highest ever recorded and representing an increase of $23,000,000 over 1919. Bricks showed the largest gain recorded by any clay product in 1920. The average price per one thousand in 1920, according to the survey, was $17.27, as compared with $12.79 in 1919.

The quantity of fire brick marketed in 1920 was in excess of 1,000,000,000 9-in. brick, and the average value per one thousand, $46.64. The quantity of hollow tile marketed in 1920 was 2,457,000 tons and the average price per ton was $10.54. Sewer pipe increased approximately 40 per cent in value during 1920 over 1919. Face brick decreased in output, but increased in price. The average price per one thousand was $26.18 in 1920, as compared with $19.58 in 1919.

Montreal to Build 1,700 Houses

A contract for the construction of 1,700 six-room houses for sale on easy terms to lot owners was recently let to the Anglin Norcross Co., Montreal, by the city of Montreal. The houses are to be sold at about $6,000 each. They are to be of brick, 22 x 30 ft., and of two stories. The total cost of the houses will be well in excess of $10,000,000. Work is to begin on the housing project immediately.

Buffalo Brick Makers Indicted

The grand jury which took up the inquiry into alleged illegal practices in the Buffalo building industry has returned additional indictments, three brick manufacturers being the defendants. Six individuals identified with the three companies are involved in the indictments. Bail of $2,000 was fixed in each case and the defendants have entered pleas of not guilty. The indictments are a result of the investigation recently carried on by the Lockwood joint legislative committee on housing

Supply and Demand for Labor in New York State

The chief statistician of the New York State Department of Labor recently reported through the labor market bulletin that the ratio of workers seeking employment to each 100 places available was 139 in June compared with a ratio of 137 reported in May. Among the cities included in the report increases between May and June in proportion of workers who registered for work to positions open appear Albany, Binghamton, Buffalo and Syracuse. The occupations which show an increase in unemployment during the month are building work, casual labor and clerical work.

Contractors Get Itemized Bids on Road Job Opening

Every contractor who bid at the New York State Highway Department bid opening held Friday, Aug. 12, and practically every contractor who now has a highway contract in New York, received in the mail August 13, a printed book containing all the unit prices bid the previous day. There were 106 proposals, some with more than thirty items. It was past four o'clock Friday afternoon when the reading was concluded and before midnight the printed book with all the unit prices was in the mail. This enabled the contractors in all the larger cities of the state to get the book in Saturday morning's mail.

The book was sent to the contractors by Fuller & O'Brien, Albany, who represent the Fidelity & Casualty Co., New York City, and who are also sales agents for road materials and equipment. Fuller & O'Brien have a free service bureau for contractors.

New York Lets Road Contracts to Value of $2,000,000

On August 12 and 16 the New York State Highway Commission let twenty-two highway construction and reconstruction projects upon which the engineer's estimate was $2,245,869 and upon which the total low bid amounted to $1,979,013. Eleven contracts involving the construction and repair of about 25 miles of durable pavements were let on Aug. 12 and eleven more involving 38 miles of roads were let on Aug. 16. There were 140 bidders on the twenty-two projects, and the total low bid was only 90 per cent of the engineer's estimate for the work.

Is There a Price Level?

A review of the general building situation by R. C. Marshall, Jr., general manager of the Associated General Contractors of America, as abstracted by *Engineering News-Record* and published in the issue of Aug. 18, p. 300, incorrectly noted the fact that the original discussion would appear in the September issue of the A. G. C. *Bulletin*. The article in question appears in the August number.

Reduced Lumber Rates from South to Middle West

Reduced rates on lumber from the South to the Middle West, as ordered by the Interstate Commerce Commission, went into effect Aug. 19. It is the general purpose of the order to equalize the effects of the recent freight rate increases on shipments to the western and middle western center of consumption, from the Pacific Coast and from the Southern lumber producers. It has been contended by the Southern lumbermen that rates to points in Iowa, Kansas and Nebraska were relatively higher than they should be, with the result that their share of the lumber business in these states has been gradually diminishing. The rates that have gone into effect are from 5 to 15 per cent less from points in Mississippi, Arkansas, Louisiana (west of the Mississippi River), Texas and Oklahoma to destinations in Iowa, Minnesota, Nebraska, Kansas and Oklahoma.

Twenty-five Projects Entail Expenditure of $60,000,000

Twenty-five construction projects, some of which have been put under contract, reported upon in this issue of *Engineering News-Record*, will entail the expenditure of more than $60,000,000. Each project is over $1,000,000, and the largest is $11,000,000, a transmission line, tunnel, and subsurface installations planned by the Niagara Falls Power Co. Eight contracts that actually have been let will involve a cost of $18,317,000, and nine projects, upon which bids are either being received or soon will be, will cost $17,300,000. Proposed work, totaling $25,000,000, brings the total to $60,617,000. The largest contract let is for the construction of a $6,500,000 hotel at Montreal.

Iron and Steel Products Reduced

The Link-Belt Co., Philadelphia, Chicago and Indianapolis, has announced a reduction in its price of malleable iron and steel chains, sprockets and other products of 10 per cent. The reduction becomes effective at once. The company also announces that discounts are obtainable upon application.

Building in New York Cities

According to the labor market bulletin recently issued from the office of the New York State Department of Labor the total value of building operations authorized during the first half of the 1921 was $200,634,300 or 2 per cent greater than the amount reported during the same period in 1920. This gain occurred chiefly in May and June. Due to the decline in cost of building materials the increase in actual amount of building work planned in the first half of 1921 over the corresponding period of 1920 was probably greater than the 2 per cent indicated above, continues the report.

Another important fact brought out in the comparison between the two

years, continues the report, is the fact that the value of new building work authorized in the state as a whole during the first half of 1921 constitued 86 per cent of the total amount reported, while the cost of new buildings authorized during the same period in 1920 was only 79 per cent of the total. This is pointed to as an indication that there is at present a greater tendency to construct new buildings.

New York Firm Awarded Contract in Australia

Milliken Bros. Mfg. Company, Inc., New York City, has recently been awarded a contract totalling about £75,000, sterling, plus freight, according to an announcement made recently by the electricity commissioners of Melbourne, Australia. The contract covers the erection of a 112-mile transmission line bringing high tension power from Victoria Falls, Australia, to Melbourne and includes a total of 634 steel towers to carry a current of 133,000 volts. German, British and Australian companies all submitted bids. The line is a state enterprise, the power to be sold to manufacturers near Melbourne.

One of the vice-presidents of Milliken Bros. is already en route to Melbourne to start the work.

Weekly Construction Market

THIS limited price list is published weekly for the purpose of giving current prices on the principal construction materials, and of noting important price changes on the less important materials. Moreover, only the chief cities are quoted.

The first issue of each month carries complete quotations for all construction materials and for the important cities. The last complete list will be found in the issue of August 4, the next on September 1.

Steel Products:	New York	Atlanta	Dallas	Chicago	Minneapolis	Denver	San Francisco	Seattle	Montreal
Structural shapes, 100 lb.	$2.88	$3.50	−$4.00	$2.88	$3.16	$4.10	$3.70	−$4.00	$5.00
Structural rivets, 100 lb.	4.40	5.25	−5.50	3.88	5.20	4.25	5.50	5.25	8.50
Reinforcing bars, ¾ in. and larger, 100 lb.	2.78	3.20	3.50	2.78	3.18	3.97½	2.35	3.75	4.25
Steel pipe, black, 3½ to 6 in. lap, discount	51%	52.65–5%	45%	53½%	53.9–5%	36%	46.25%	47½%	5%
Cast-iron pipe, 6 in. and over, ton	48.30	43.33	−53.30	46.10	52.80	57.50	60.00	63.00	75.00
Concreting Material:									
Cement without bags, bbl.	2.60@2.70(del.)	2.75	2.80	2.17	2.41	3.10	3.09	3.10	2.75
Gravel, ¾ in., cu.yd.	2.25	2.25	3.00	1.80	2.00	2.50	2.25	1.50	1.50
Sand, cu.yd.	1.25	1.35	2.50	1.80	1.00	1.10	1.50	1.50	1.25
Crushed stone, ¾ in., cu.yd.	1.90 to 2.00	2.25	2.80	2.00	2.25	3.50	2.25	3.50	2.10
Miscellaneous:									
Pine, 3x12 to 12x12, 20 ft. and under, M.ft.	−45.00	38.00	35.00	49.00	34.00	+49.00	+30.00	+21.50	120.00
Lime, finishing, hydrated, ton	16.99	19.00	25.00	20.00	29.00	−30.00	25.40	24.00	28.00
Lime common, lump, per bbl.	3.69	1.50	2.75	1.65	1.50	−2.95	2.25	2.75	15.00
Common brick, delivered, 1,000	18.40	10.00	+12.72	11.00	17.00	14.00	18.00	14.00	18.00
Hollow building tile, 4x12x12, block	Not used	.14	.13	.0926	.092	.09	.12½	.11	.15
Hollow partition tile 4x12x12, block	.105	.14	.13	.07410	.092	.10	.14½	.12	.....
Linseed oil, raw, 5 bbl. lots, gal.	.80	.86	+.98	−.80	.90	+.98	−.95	.79	.84
Common Labor:									
Common labor, union, hour	.75@.80	.35	.....	1.00	.50	.50@.63½	.81½	.75	.....
Common labor, non-union, hour	.....	.20	.35@.45	.40	.50	.37½@.50	.50@.55	.50	.30

Explanation of Prices—Prices are to contractors in carload lots unless other quantities are specified. Increases or decreases from previous quotations are indicated by + or − signs. For steel pipe, the prevailing discount from list price is given: 45-5% means a discount of 45 and 5 per cent, 45@50 means a range of 45 to 50 per cent. Charge of 15c. per 100 lb. for cutting reinforced steel into 2-ft. lengths or over. **New York** quotations are delivered except tiles, which are "on trucks." Common lump lime per 280-lb. net; both lump and hydrated quoted f.o.b. cars New York. Sand gravel and crushed stone are quoted alongside dock. **Chicago** quotes hydrated lime in 50-lb. bags. **Minneapolis** quotes on fir instead of pine. Brick and hollow tile delivered. Cement on cars; $2.60 delivered. Gravel, sand and crushed stone quote at pit. We quote on brown lime; white is $1.80 for Kelly Island and $1.65 for Sheboygan. Common labor not organized. **Denver** quotes cement "on tracks"; gravel and sand at pit, stone on cars, lime, brick, hollow tile and lumber on job. Tile price is at warehouse. Linseed oil, delivered. **Atlanta** quotes sand, stone and gravel per ton instead of cu.yd. **Dallas** quotes lime per 180-lb. bbl. Steel, cast-iron pipe and crushed stone f.o.b. cars, other materials delivered. **San Francisco** quotes on Heath tile, 5½ x 8 x 11½. Prices are all f.o.b. warehouses except C. I. pipe, which is mill price plus freight to railway depot at any terminal. Lumber prices are delivered "at ship tackle in San Francisco ex mill." **Seattle** quotes on Douglas fir instead of pine; and on lime in paper bags. **Montreal** quotes sand stone, gravel and lump lime per ton. Cement, lime and tile are delivered; sand, gravel and stone, on siding; brick f.o.b. plant; steel and pipe at warehouse. Cement price is in Canadian funds, exchange with the United States being 14 per cent at present. Bag change is 80c. per bbl. Discount of 10c. per bbl. for payment within 20 days from date of shipment.

Changes Since Last Week

New York warehouses continue to quote structural steel shapes and plates at $2.88 and soft-steel bars at $2.78. Although the general tone of the warehouse business is encouraging, mill shipments continue inactive. New York quotes mill shipments of structural shapes and plates at $2.18@$2.23, and bars at $2.13. The regular Pittsburgh prices of $1.75 for steel bars and $1.85 for plates and shapes seem to be generally adhered to. Cutting under these prices from 5c. to 15c. per 100 lb. has been rumored, but is not generally practiced. In Dallas, structural shapes have been reduced 20c., to $4, and rivets from $5.755 to $5.50.

Seattle reports lumber demand improving, with a price advance of 50c. per M. ft. b.m. in Douglas fir. Pine has advanced from $47 to $49 per M. ft. in Denver, and from $27 to $30 in San Francisco. The New York wholesale market on pine is off $2 on the base size, the price for 12-in. now being $40; for 10-in., $37, and for 8-in. and under, $34. The larger sizes sell for $46 (14 x 14), and $52 (16 x 16). New York prices are wholesale, the price to contractors being about $5 higher than these quotations.

Denver quotes a reduction in hydrated, finishing lime from $32 to $30 per ton, and in common lump lime from $3.10 to $2.95 per bbl. delivered.

Demand for common brick has been unusually heavy in the New York district during the last week, with prices unchanged. Dallas reports an advance from $12.65 to $12.72.

Fluctuations in linseed oil prices are shown throughout the country. Dallas reports a rise of 1c. and Denver a rise of 2c. per gal.; while the Chicago price drops 4c., and San Francisco 1c. per gal. (5-bbl. lots). Two of the important explosives manufacturers have just announced a decrease of 25c. per 100 lb.

Cleveland quotes the following labor rates: skilled labor, at $1.04 per hr.; pile drivers, at 91c.; hod-carriers, at 60c., and common labor, at 57½c.

San Francisco reports lockout still on, but there seem to be more men at work on the American plan. In Atlanta nonunion, common labor is available at 20c. As giving a line on labor conditions in Philadelphia, on a $200,000 sewer job, the following estimates for the labor were tendered:

Labor, per hour	A.	B.	C.
Foreman	0.80	0.75	1.00
Carpenter	1.00	0.80	1.00
Bricklayer	1.00	0.80	1.00
Cement finisher	0.75	1.25	1.25
Common labor	0.90	0.40	0.60